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SEVENTH EDITION

OIL INDUSTRY OUTLOOK

1991—1995

BY ROBERT J. BECK
ECONOMICS EDITOR
OIL & GAS JOURNAL

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OIL INDUSTRY OUTLOOK

by **Robert J. Beck, Economics Editors,**
Oil & Gas Journal

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The footnote finally came true.

Appearing in nearly every petroleum industry forecast of the early 1980s, it had all but disappeared after the crude oil price collapse of 1986. But the warning, this once-standard footnote, never left the minds of people who buy and sell petroleum: If something interrupts crude oil exports from the Middle East, all analytical bets are off.

The footnote came true on Aug. 2, 1990. Iraq's massive and battle-hardened army invaded largely undefended Kuwait, routed the ruling family, and pillaged Kuwait City. Within days, thanks to a retaliatory international embargo, the petroleum market had lost the 4.3 million b/d of crude oil and products that Iraq and Kuwait had exported prior to the invasion. Continuation of the Iraqi march southward into Saudi Arabia seemed inevitable. Led by the United States, an unprecedented international military force quickly built up to stop the advance.

In the tense weeks of stalemate that followed, the average Organization of Petroleum Exporting Countries export crude oil price shot from less than $18/bbl before the invasion to nearly $27/bbl in September. On the New York Mercantile Exchange, the near-month futures price for light, sweet crude in September reached $40/bbl. Spot and futures prices swung widely on rumors of imminent war or truce.

Politics turned tumultuous as well. In the United States and Europe, gasoline and heating oil consumers decried the sudden runup in product prices. Some newspapers and politicians called for price and allocation controls and "windfall profit" taxes and blustered against profit increases they expected oil companies to report for the year's third quarter. Not until the end of the third quarter did leaders of major consuming nations consider drawing down strategic oil inventories; there was no physical shortage, they said.

Consumers and politicians had forgotten the footnote; crude oil traders had not. This was it. This was the Middle Eastern disruption that threw off all analytical bets. Moreover, this was shortage, to the extent a freely working oil market ever allows shortage to exist. And if war broke out, the shortage might worsen if hostilities extended to other producing countries or shipping lanes.

Even before Iraq's takeover of Kuwait, the end of a long period of surplus had come into view. The International Energy Agency projected fourth quarter 1990 demand for OPEC crude at 24.6 million b/d—nearly 90% of the group's sustainable production capacity. Plans for major capacity additions emerged from key members, including Saudi Arabia (to 10 million b/d from 7 million b/d) and Venezuela (to 3.5-4 million b/d from 2.6 million b/d). In a late-July ministerial meeting, the group raised its production quota and target price for the second half of the year.

It was obvious then that something was out of plumb. The July production agreement was wildly optimistic. Throughout the year, Kuwait and the United Arab Emirates had produced significantly in excess of their assigned quotas—Kuwait by 300,000–400,000 b/d, the U.A.E. by 1 million b/d. Total OPEC production thus averaged 24.1 million b/d early in the second quarter, compared with the first-half quota of 22.086 million and first-half demand for OPEC crude of no more than 23.7 million b/d. The results, as always in periods of OPEC overproduction, were rising worldwide crude oil inventories and falling prices.

When OPEC ministers met in July to adjust quotas, therefore, a new stock overhang loomed as a competing source of supply for the remainder of the third quarter and into the high-demand fourth. Although they could see demand for their crude at last catching up with their ability to produce, OPEC ministers had to contend with the near-term consequences of the recent production spree. In those circumstances, an agreement to push the group quota to 22.491 million b/d and raise the target price to $21/bbl from $18/bbl looked very suspicious. In fact, with the quota still promising a 400,000 b/d inventory build through

at least the third quarter, it looked altogether futile.

Of course, there was more involved in the OPEC agreement than near-term market dynamics. Its main supporter was Iraq, whose president, Saddam Hussein, had given a series of speeches denouncing overproduction by OPEC's Arab mavericks. The U.A.E. claimed never to have accepted its 1.095 million b/d OPEC quota and wanted at least parity with Kuwait's 1.5 million b/d ceiling. For its part, Kuwait seemed to insist that if the U.A.E. could overproduce then it could, too.

The motivations may have gone beyond intramural quota competition. Kuwait had long feared invasion by Iraq, which despite agreements to the contrary, never considered its tiny neighbor anything other than a southern province. Watching Iraq rapidly rebuild its military forces following the ceasefire with Iran, Kuwait had excellent reason to deliberately feed a worldwide oil surplus and thereby keep oil prices low and it's antagonist in financial distress. Indeed, among his sundry stated reasons for invading Kuwait, Saddam Hussein said he wanted to punish Kuwait for its OPEC disobedience.

So the market entered fourth quarter 1990 frantic about the possibility of another Middle East war and busily adjusting to preclude physical shortage. By the end of August, IEA had reduced its projection of fourth-quarter consumption outside centrally planned economies to 54.5 million b/d from the 55.3 million b/d it had projected just one month earlier. Net of production and stock adjustments, this cut the implied call on OPEC crude in the quarter to an average of 24 million b/d. The market thus was doing its job: raising price to reduce demand and stimulate production.

But a problem remained. Without Kuwait and Iraq, which together represented 5.7 million b/d of production capacity, OPEC couldn't produce all of the 24 million b/d that IEA indicated the world would need in the fourth quarter from its members. According to the U.S. Central Intelligence Agency, OPEC without Kuwait and Iraq might produce 22.34 million b/d for a few months but only 21.74 million b/d on a sustained basis. With OPEC producing at a near-term capacity, therefore, the market still would face a fourth quarter shortfall of at least 1.6 million b/d.

At the beginning of the fourth quarter, therefore, further market adjustments were in order—more consumption cuts, greater supply to the extent increases were physically possible, and higher prices. And the adjustments could mean only further damage to worldwide economies.

For the oil industry, events of 1990 meant intense political pressure, short-term gains in upstream earnings, and a new round of uncertainty. Thank to Saddam Hussein, all analytical bets were off. And oil industry planners and analysts had a new footnote: At some point, it all would end. At some point, the threat of war would subside, and 5.7 million b/d of production capacity from Iraq and Kuwait would again be a factor in worldwide supply. At some point, the world would again be able to produce more oil than it needed.

At the beginning of fourth quarter 1990, then, the petroleum industry had a vital new question with no certain answer: When would the new footnote come true?

Bob Tippee

Managing Editor

Economics and Exploration

Oil & Gas Journal

INTRODUCTION

Over the past several years, volatile and frequent changes have plagued planning for the worldwide oil and gas industry. When it appeared that the oil industry might become predictable, problems arose that made old projections obsolete and new forecasts uncertain. The worldwide and United States oil and gas industries have been shaped and reshaped by changing political and economic events. This is particularly true this year.

This outlook book is being prepared immediately following the Iraqi invasion of Kuwait. The oil market has lost a substantial volume of crude oil. The price of crude oil has climbed 50% from the level prior to the invasion. The market is facing potential shortages during the usual periods of peak demand. It would have been impossible to predict these events, and it is now extremely difficult to predict future events in the industry.

The purpose of the past editions of the *Oil Industry Outlook* book have been to present the "most likely economic outlook" for the worldwide and U.S. oil industries over the ensuing five years. This was done by reflecting on past and current economic events and projecting future trends in key parameters that measure activity in the industry. Assumptions were made about the political objectives of various countries only if they were economic objectives. No attempt was made to predict other political objectives and events because it was deemed impossible to make these predictions accurately.

Because of the current crisis in the Middle East, the industry is almost being forced to predict future political events. To get around the necessity of trying to predict political events and the timing of these events, this edition of the *Oil Industry Outlook* will present three separate scenarios. These three scenarios will vary in their projections of what will likely happen in the oil industry over the next five years.

There are almost an unlimited number of scenarios that could be constructed with respect to the situation in the Middle East and its future impact on the oil industry. What is presente in this booklet are three scenarios that are deemed to be almost equally likely to occur.

What should be remembered is that profitable long-term survival for many companies in the industry may still be dependent upon their being aware of possible future changes and how these changes will shape the future. This outlook is being produced to provide some guidance and to assist in assessing the most likely route to the future.

In the past several years it was the overhanging surplus oil productive capacity in the world and OPEC that had the most influence over the level of prices and therefore influence over the level of activity in the industry. Most past outlooks attempted to determine when this excess capacity would be eliminated and alleviate the downward pressure on prices. Overnight the Iraqi invasion of Kuwait and the subsequent embargo of crude exports from these two countries has temporarily eliminated the excess capacity and changed the economic conditions of the world oil market.

Many things in the industry may change if the oil price remains elevated for an extended period of time. Demand for petroleum products will probably be reduced. And there could be an impact on total energy demand and economic growth.

On the supply side, the higher prices could stimulate additional exploration activity in the non-OPEC countries. OPEC countries other than Iraq and Kuwait might choose to increase production capacity to make up for the lost production. Refiners may have to adjust future capacity plans because of the new level of demand.

This is only a partial list of the adjustments that may be made due to the abrupt and significant change in the price level of crude oil. But what should be remembered is that the two countries now involved in the dispute have huge oil reserves. It is highly unlikely that these reserves will somehow be totally removed from the equation that determines the world oil supply demand balance. The existence of this large supply of proved oil reserves in Iraq and Kuwait is a key element in the three scenarios presented in this edition of the Oil Industry Outlook.

Decisions can not be delayed indefinitely. Therefore some projections of expected economic activity in the industry are essential. Even with today's uncertainty, an outlook of some form must be developed. And even with the uncertainty, these outlooks will have some value in the decision-making process.

Change and uncertainty have been recurring themes in oil industry forecasts. They are not new. Anyone close to it will tell you that the only thing certain about the oil industry is change—uncertainty and risk. In today's environment the entire foundation for making projections, forecasts and decisions is unstable. About the only thing that is certain is that the future will not look like the past. And that means any new investment entails substantial risk: the risk inherent with change.

Forecasts are a valuable, essential tool for decision-making. The "bottom line" for the forecasting industry is a better decision. The more information obtained to assist operating and investment decisions, and the clearer the understanding of potential future events that will affect the industry, the more likely that a decision will make a positive contribution to a company's performance. A decision is seldom, if ever, 100% right or wrong. The outcome is usually some gradation of right or wrong. Any information that can improve the decision and increase the overall return on the company's investment is a valuable addition.

Forecasts and projections can be useful tools that help reduce risk. But in order to be a useful tool, a forecast must be based on an understanding of recent events and their effect on the industry. The forecast must be internally logical and consistent, and it must use tried and tested economic theory as a framework.

All forecasts or outlooks are founded on a set of assumptions. It is essential that the basic assumptions used and conclusions drawn are logical, and hold together based on an understanding of the industry. It is essential that they reflect the actual workings of the industry and the economic system of the industry.

The industry is changing, but the outcome is still determined by basic economic principles. Recent events may be shaping the future industry, but historical relationships should not be discarded. Political, non-economic events can upset the best forecast. But if a forecast is to be an aid in decision-making, it must be based on known economic relationships rather than imagined future political events. This is also true in today's market when political events have drastically changed the economic relationships.

This outlook book has been developed to provide industry decision makers and analysts with a number of useful analytical tools. It is an outlook for the worldwide and domestic oil and gas industry for the next five years. It is a review of recent events that have had a major impact on the industry. And it is a guide to the factors to consider when preparing your own forecast for decision-making.

In addition, the book provides the essential oil and gas industry historical data for additional individual analysis. This enables the adoption of an alternative set of assumptions and the development of alternative outlooks. Although a decision must be based on one perception of the future, a set of alternative assumptions and forecasts often aids decision making. Alternative outlooks can provide the framework for accessing the penalties or rewards from being wrong about the future.

In order to operate profitably in the future it is essential that companies develop a strategy for adapting to the changes occurring in the industry and a strategy for operating under the new conditions in the industry. The strategy that worked in the 1970s and 1980s will not necessarily work in the 1990s.

This outlook can be of assistance in clarifying recent events and trends, and providing a logical and consistent outlook. The future may be filled with a great deal of uncertainty, but it is also filled with exciting opportunities. The only way to take advantage of those opportunities is to make the necessary decisions and take the required risks. This book has been prepared to help reduce those risks and help make the decisions more profitable.

WORLDWIDE OUTLOOK—DEMAND

This outlook will start with a close look at worldwide demand for energy and petroleum products. Worldwide petroleum demand has always been one of the major determinants of trends in the oil and gas industry. But this outlook is being developed at a time when political considerations are having a greater influence than economic factors on the oil market. Over the past several years the increase in demand played a major role in balancing the market

with political factors having more influence than economic factors over the oil market, forecasting becomes markedly more difficult. Therefore, rather than presenting one base case or "best" outlook, three scenarios have been presented for your consideration and review.

The initial focus in this chapter will be on the recent trends in petroleum demand for the worldwide industry. These trends provide the background information needed to grasp the relationship between the many factors that influence worldwide oil demand. There are regional differences in oil industry activity throughout the world. But to a great extent the oil industry is a global rather than a regional industry. In this chapter the recent trends and events in the industry will be expanded into a global outlook.

This global outlook is the required basis for creating any regional projections. The United States, European, or any other regional oil industry is closely interrelated with activities in the worldwide industry. Any regional analysis must give consideration to the impact of worldwide economic and energy industry events.

Past trends in demand for petroleum products and the key factors that determine the level of petroleum product demand will be looked at in the first part of this section. These recent trends and relationships are important determinants of future product demand.

Generally, once the present situation in the industry had been established, it would be followed by a presentation of the outlook for worldwide demand for energy and petroleum products for the next five years. However, current conditions in the Middle East are so chaotic that it is very difficult to establish a basis for a sound economic projection. Therefore, this year, following the review of past trends, there will be a discussion of possible scenarios that could evolve from the current situation in the Persian Gulf.

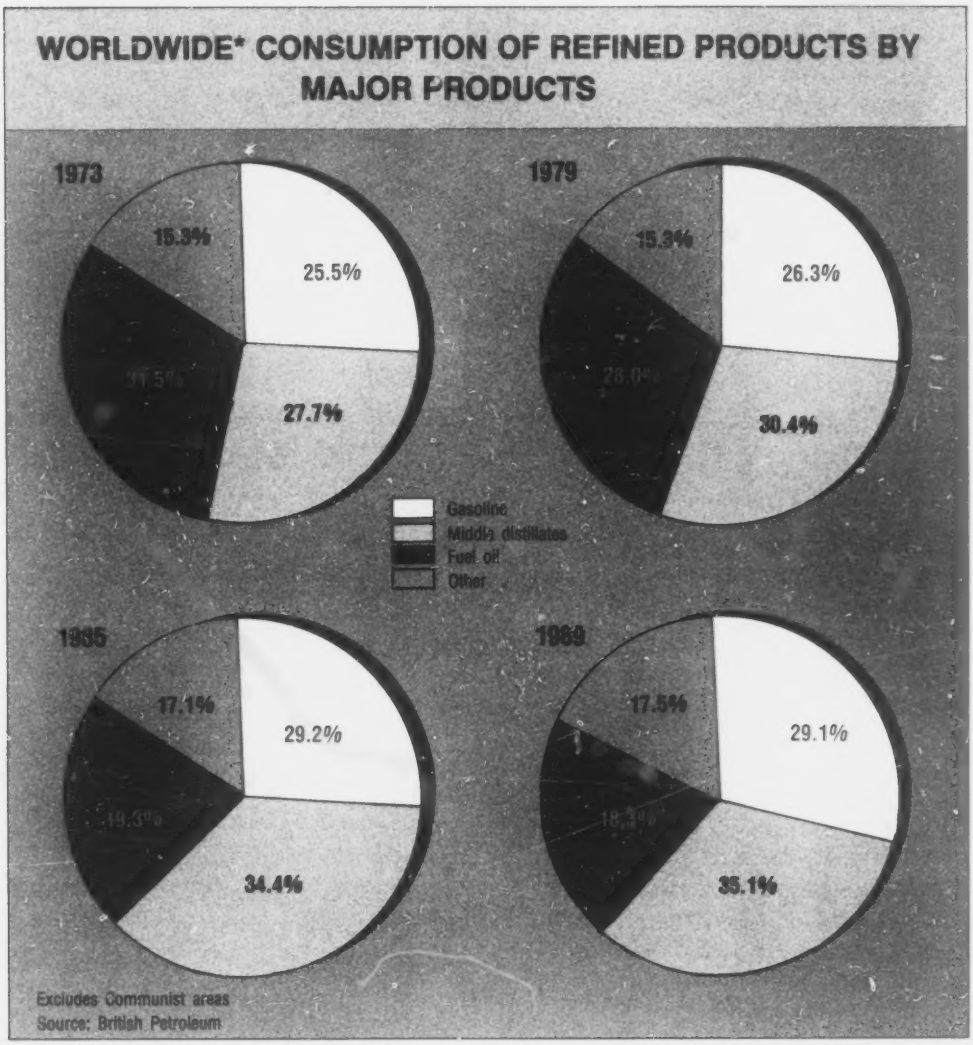
The level of worldwide economic activity is still a major factor in determining demand for energy and oil products. Energy is an essential input for all types of economic activity. Therefore there is an extremely close relationship between economic activity and energy consumption. Although the relationship has changed over time, and has been rather volatile recently, as long as there is economic activity large quantities of energy will be consumed in some form. In today's modern economic systems with high levels of economic activity, vast quantities of energy are consumed, in a wide variety of forms and from many sources.

There are several basic energy sources and two of the most important of these sources are oil and natural gas. Oil products and natural gas are consumed throughout the world in a variety of geographic areas with differing levels and types of economic activity. Oil products are consumed throughout the world, in the industrial economies, the developing economies, and in the Centrally Planned Economies of the formerly communist countries.

In all areas of the world, demand for oil products and natural gas to fuel economic activity is the determinant of the level of activity in the oil industry. Therefore energy needs and natural gas and petroleum product demand, throughout the world, have been analyzed as a basis for this outlook.

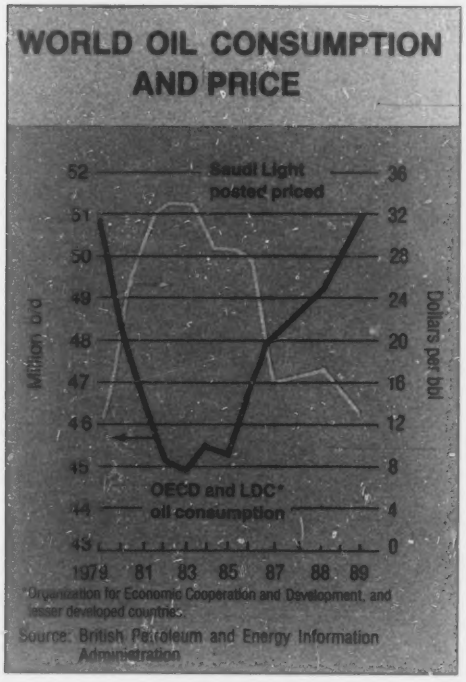
With the close relationship between economic activity and energy consumption, it becomes apparent that expectations for the future level of worldwide economic activity are still the key determinants of the future demand for oil and gas.

But the price of energy in general and price of the individual forms of energy, such as oil and natural gas, also play a major role in determining the level of demand. The relationship between economic activity and energy consumption was altered dramatically over the past 10 to 15 years, because of the volatility of the cost/price of energy. The and also somewhat in stabilizing prices. But at this time the industry is looking at a possible supply shortage and a possible sharp increase



in prices. Rather than economic growth determining demand, it is possible that in the first few years of the forecast period price and available supply may have a greater influence on demand. rapid increase in the cost of oil, and energy in general, broke the lockstep relationship between economic growth and energy consumption. With much higher prices for energy and petroleum products, conservation became a dominant factor determining the level of energy and oil consumption. The impact of conservation on demand was reduced in recent years as prices moderated. The ever- changing relationship between demand and price is reviewed in this section.

But recent events in the Middle East have resulted in a sharp increase in the price of oil and the cost of energy to fuel economic activity. The future level of worldwide demand for energy and petroleum will depend to a great extent on the outcome and the time it takes to resolve this crisis.



REVIEW

ECONOMIC ACTIVITY. Even though political actions are currently the most important factor influencing the oil market, the level of worldwide economic activity is still a key determinant of energy demand. Therefore, a review of recent trends in economic activity is appropriate in analyzing and establishing the current link between economic activity and energy consumption.

There is no aggregate measure of overall world economic activity. The statistics required to measure overall economic activity in many of the developing areas are not collected or even available. Only rough estimates can be made of the level of activity. There are some regional measures, but these are mainly for the industrial countries.

Aggregate economic activity is measured for the countries in the Organization for Economic Cooperation and Development (OECD). This is a group of 24 industrial countries. Overall, economic activity for this group increased in 1987 after slumping for two years, 1985–1986. The growth of real GNP/GDP moved up to 3.4% from 2.8% in 1986. The rate of growth increased to 4.4% in 1988, and then slowed a bit to 3.6% in 1989. Lower energy prices can be given some credit for stimulating economic growth since 1986. However, even before the oil crisis in the Middle East, it was expected that the rate of economic growth would slow to 2.9% in 1990 and 1991. A recent report by the OECD gave estimated economic growth rates for the major industrial countries and the group as a whole. This report projected an economic slowdown in 1990 and 1991. But it did expect continued growth and did not project a recession.

According to this report, in 1988 Japan, Canada, Italy, the United States, Germany, France, and the United Kingdom, among the larger countries, led the way to higher growth for the OECD. Growth continued in 1989 but at a slower pace. Japan's growth rate moved up to 5.7% in 1988, from 4.5% the year before and only 2.4% in 1986. In 1989, Japan's economic activity grew at 4.9% and it is expected to drop to only 4.7% in 1990. Canada posted a growth rate of 5.0% in 1988, compared to 4% in 1987 and only 3.2% in 1986. Growth slowed to 2.9% in 1989 and is expected to be down again in 1990 at 2.0%. Italy had a 4.2% growth rate in 1988, up from 3% in 1987 and 2.5% in 1986. This fell to 3.2% in 1989 and is estimated at 3.1% in 1990. Economic growth in the U.S. moved up to 4.4% in 1988 compared to 3.4% the year before and 2.8% in 1986. This fell to 3.0% in 1989 and is expected to slump to 2.3% in 1990. The U.K. posted a 4.5% growth rate in 1988. This was down from 4.6% in 1987 but higher than the 3.2% in 1986. The growth rate fell to 2.3% in 1989 and is expected to slow to 0.9% in 1990.

Germany's economic growth rate moved up to 3.6% in 1988, from only 1.8% in 1987, and

2.3% in 1986. This moved up to 4.0% in 1989 but is estimated to slip in 1990 to 3.9%. France posted growth of 3.8% in 1988, up from 1.9% in 1987 and 2.3% the year before. This is expected to slow to 3.1% in 1990 and 2.9% in 1991.

The group of smaller European countries had an aggregate economic growth rate of 3.4% in 1988 up from 2.9% in 1987 and 2.7% in 1986. This climbed to 3.8% in 1989 but is estimated to fall to 2.5% in 1990. Australia's rate dropped slightly in 1988 to 3.6% from 4.5% in 1987. But it was up from only 2.1% in 1986. Growth bounced back to 4.9% in 1989, but is estimated to slump to only 0.3% in 1990. New Zealand's growth rate moved up to a positive 0.3% in 1988 after two years of recession, -0.1% in 1987 and -3.5% in 1986. It is estimated at +1.7% in 1990.

As can be seen, there were wide-ranging differences in the growth rates between the OECD countries in 1988 and 1989. But all but two, Denmark, -0.2%, and Iceland -1.4%, posted positive rates in 1988, and all but Iceland, -3.8%, were positive in 1989.

The aggregate growth rate for these countries has moved up to a higher level in recent years, stimulated by the availability of lower cost energy. However, it should be noted that the internal cost of energy is determined by many factors and is not the same in each country.

The OECD economic growth rates for 1988, 4.4%, and 1989, 3.6% were considerably higher than the long term rate of about 2.5% per year. Even the estimated rate of 2.9% for 1990 was above the long-term rate. But this rate has not been constant and the OECD has gone through a number of cycles. The cost of energy has been responsible for some of the cyclical nature of that economic
growth.

Over the period of 1972 to 1982, aggregate real economic growth for the total group of countries averaged 2.5% per year. The most recent economic recession hit a trough in most of the industrial countries during the fourth quarter of 1982. Aggregate economic activity for the OECD dropped down to 0.5% in 1982.

WORLDWIDE PETROLEUM PRODUCT MARKET SHARE

	1973 (%)	1976 (%)	1979 (%)	1982 (%)	1985 (%)	1989 (%)
U.S. and CANADA						
Gasoline	37.6	38.5	37.3	41.5	42.2	41.5
Middle distillates	25.2	25.7	27.0	26.9	28.7	29.4
Fuel oil	18.4	18.0	17.1	12.9	9.2	9.5
Other	18.8	17.8	18.6	18.7	19.9	19.6
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
WESTERN EUROPE and JAPAN						
Gasoline	17.2	18.5	19.4	21.4	23.0	24.5
Middle distillates	29.4	30.8	32.0	33.9	37.3	38.2
Fuel oil	40.5	38.4	35.4	29.8	23.4	20.5
Other	12.9	12.3	13.2	14.9	16.3	16.8
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
REST OF WORLD*						
Gasoline	19.1	18.6	19.0	19.7	20.2	19.5
Middle distillates	29.0	32.7	33.6	36.2	38.2	38.4
Fuel oil	37.8	34.6	33.9	30.1	27.0	26.4
Other	14.1	14.1	13.5	14.0	14.6	15.7
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
TOTAL WORLD*						
Gasoline	25.5	26.4	26.3	28.1	29.2	29.1
Middle distillates	27.7	29.2	30.4	32.0	34.4	35.1
Fuel oil	31.5	29.6	28.0	23.9	19.3	18.3
Other	15.3	14.8	15.3	16.0	17.1	17.5
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

*Excludes communist areas

Source: British Petroleum

An upturn in economic activity started slowly in 1983. Real economic growth for the OECD group was 2.7% in 1983. The rate of growth accelerated in 1984, and the OECD total economic activity increased 4.9%. Economic growth slowed a bit in 1985 and 1986 with OECD aggregate activity up 3.2% and 2.8% respectively.

The growth in the U.S. economy led the way in 1983 and 1984 as real U.S. GNP increased 3.6% in 1983 and 6.8% in 1984. But U.S. economic growth slowed to 3.4% in 1985 and 2.8% in 1986.

Japan followed with an increase in economic activity of 3.2% in 1983 and 5.1% in 1984. Japan's growth slowed to 4.9% in 1985 and 2.5% in 1986. Canada posted a rate of economic growth of 3.2% in 1983, 6.3% in 1984, 4.3% in 1985 and 3.2% in 1986.

The United Kingdom posted a slightly different pattern with a 1983 rate of 3.3%, 1984 -2.6%, 1985 -3.6%, and 1986 +3.2%. Germany had

WORLDWIDE PRIMARY ENERGY CONSUMPTION AND MARKET SHARE

	1974	% of total	1976	% of total	1979	% of total	1982	% of total	1984	% of total	1986	% of total	1988	% of total	1989	% of total
	(Million barrels oil equivalent)															
Oil	20,234	46.4	21,217	46.0	22,907	45.0	20,461	40.6	20,693	39.1	21,252	38.2	22,377	38.9	22,707	38.7
Natural gas	7,976	18.3	8,398	18.2	9,405	18.5	9,746	19.4	10,585	2.0	10,901	19.6	12,029	20.9	12,515	21.3
Coal	12,396	28.4	13,086	28.4	14,431	28.3	14,998	29.8	15,946	30.1	16,993	30.5	16,118	28.0	16,355	27.8
Water power	2,519	5.8	2,627	5.7	3,058	6.0	3,361	6.7	3,614	6.8	3,787	6.8	3,856	6.7	3,857	6.6
Nuclear	457	1.1	770	1.7	1,121	2.2	1,794	3.5	2,137	4.0	2,761	4.9	3,190	5.5	3,303	5.6
Total*	**43,582**	**100.0**	**46,098**	**100.0**	**50,922**	**100.0**	**50,360**	**100.0**	**52,975**	**100.0**	**55,694**	**100.0**	**57,570**	**100.0**	**58,737**	**100.0**

*Excludes miscellaneous fuels not mentioned specifically.

Source: British Petroleum

WORLDWIDE OIL CONSUMPTION

Country Area	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	% change 89/79	% change 89/83
	(1,000 b/d)												
North America													
U.S.*†	17,910	16,460	15,550	14,765	14,745	15,175	15,170	15,670	16,035	16,525	15,685	− 7.40	12.48
Canada†	1,915	1,855	1,760	1,565	1,475	1,425	1,490	1,475	1,515	1,590	1,660	−13.32	12.54
TOTAL NORTH AMERICA	**19,825**	**18,315**	**17,310**	**16,330**	**16,220**	**16,600**	**16,660**	**17,145**	**17,550**	**18,115**	**18,245**	**−7.97**	**12.48**
LATIN AMERICA	**4,445**	**4,615**	**4,660**	**4,765**	**4,680**	**4,645**	**4,645**	**4,755**	**4,985**	**5,070**	**5,265**	**18.45**	**12.50**
Western Europe													
Austria†	250	245	225	210	205	200	200	215	220	215	215	−14.00	4.88
Belgium & Luxembourg†	560	540	500	475	435	420	430	485	490	500	480	−14.29	10.34
Denmark†	320	275	260	225	215	210	220	215	200	195	185	−42.19	−13.95
Finland†	265	255	245	230	215	215	220	230	230	230	230	−13.21	6.98
France†	2,435	2,260	2,060	1,915	1,880	1,815	1,790	1,830	1,845	1,830	1,875	−23.00	− 0.27
Greece†	250	250	240	240	230	235	245	250	270	280	275	10.00	19.57
Iceland†	15	10	10	10	10	10	10	10	10	10	15	0.0	50.00
Republic of Ireland†	130	120	105	95	85	85	85	100	85	80	85	−34.62	0.00
Italy†	2,080	1,970	1,940	1,845	1,820	1,735	1,730	1,770	1,850	1,880	1,940	− 6.73	6.59
Netherlands†	855	800	745	655	625	625	635	700	705	740	740	−13.45	18.40
Norway†	200	200	190	180	180	190	200	200	215	205	195	− 2.50	8.33
Portugal†	165	170	180	195	195	195	180	195	190	185	195	18.18	0.00
Spain†	1,015	1,070	1,040	990	1,010	955	925	925	945	970	1,010	− 0.49	0.00
Sweden†	545	500	455	420	375	360	375	385	355	340	325	−40.37	−13.33
Switzerland†	270	270	250	235	260	250	255	280	265	265	255	− 5.56	− 1.92
Turkey†	300	300	315	335	330	370	345	375	435	465	465	55.00	40.91
United Kingdom†	1,945	1,670	1,560	1,580	1,530	1,850	1,630	1,645	1,610	1,690	1,730	−11.05	13.07
West Germany†	3,050	2,725	2,465	2,355	2,340	2,330	2,390	2,530	2,445	2,445	2,295	−24.75	− 1.92
TOTAL WESTERN EUROPE	**14,650**	**13,630**	**12,785**	**12,190**	**11,940**	**12,050**	**11,865**	**12,340**	**12,365**	**12,525**	**12,510**	**−14.61**	**4.77**
U.S.S.R. and Eastern Europe													
U.S.S.R.	8,640	9,065	9,155	9,095	8,970	8,980	8,950	8,995	8,985	8,885	8,795	1.79	− 1.95
Eastern Europe	2,400	2,335	2,210	2,125	2,055	2,060	2,125	2,200	2,165	2,170	2,160	−10.00	5.11
TOTAL U.S.S.R. AND EASTERN EUROPE	**11,040**	**11,400**	**11,365**	**11,220**	**11,025**	**11,040**	**11,075**	**11,195**	**11,150**	**11,055**	**10,955**	**− 0.77**	**− 0.63**
CYPRUS,GIBRALTAR MALTA	**30**	**30**	**30**	**30**	**30**	**35**	**35**	**40**	**45**	**50**	**50**	**66.67**	**66.67**
MIDDLE EAST	**1,925**	**2,020**	**2,130**	**2,190**	**2,425**	**2,540**	**2,680**	**2,660**	**2,705**	**2,805**	**2,920**	**51.69**	**20.41**
AFRICA	**1,360**	**1,450**	**1,525**	**1,610**	**1,630**	**1,630**	**1,725**	**1,705**	**1,770**	**1,820**	**1,830**	**34.56**	**12.27**
Asia													
China	1,835	1,765	1,705	1,660	1,705	1,735	1,810	2,010	2,110	2,210	2,360	28.61	38.42
Japan†	5,485	4,935	4,695	4,395	4,390	4,620	4,435	4,495	4,500	4,805	5,005	− 8.75	14.01
South Korea	490	485	480	480	505	510	515	570	605	720	825	68.37	63.37
Taiwan	265	285	270	270	300	315	330	375	395	475	515	94.34	71.67
South Asia	775	825	890	935	950	1,030	1,160	1,210	1,245	1,360	1,450	87.10	52.63
Other Asia	1,630	1,650	1,715	1,640	1,590	1,570	1,510	1,580	1,685	1,810	2,015	23.62	26.73
TOTAL ASIA	**10,480**	**9,945**	**9,755**	**9,380**	**9,440**	**9,780**	**9,760**	**10,240**	**10,540**	**11,380**	**12,170**	**16.13**	**28.92**
Australasia													
Australia†	565	630	625	610	590	610	590	610	635	650	690	3.76	16.95
New Zealand†	90	90	85	85	80	85	80	85	95	95	100	11.11	25.00
TOTAL AUSTRALASIA	**755**	**720**	**710**	**695**	**670**	**695**	**670**	**695**	**730**	**745**	**790**	**4.64**	**17.91**
TOTAL WORLD	**64,510**	**62,125**	**60,270**	**58,410**	**58,060**	**59,015**	**59,115**	**60,775**	**61,840**	**63,565**	**64,735**	**0.35**	**11.50**
OECD	**40,715**	**37,600**	**35,500**	**33,610**	**33,220**	**33,965**	**33,630**	**34,675**	**35,145**	**36,190**	**36,550**	**−10.23**	**10.02**

*U.S. processing gain has been deducted from local domestic product demand. †OECD (Organization of Economic Cooperation & Development) member.

Source: British Petroleum

a rate of 1.9% in 1983 that jumped to 3.3% in 1984, fell to 2.0% in 1985 and rose back up to 2.3% in 1986.

There are differences in the rates of growth and some differences in the cyclical patterns. But in general over this period there are striking similarities in the patterns of economic growth. Because of the increase in worldwide trade, the economic fortunes of all of the countries in the OECD appear to be closely related.

The rate of growth in economic activity for the entire OECD is estimated to be down to 2.9% in 1990. But it is still positive and above the average of 2.5%. The growth rate is estimated to be lower in all of the large major industrial countries. Economic growth is expected to remain at this level in 1991.

The growth rate for the seven largest industrial countries was 3.5% in 1989, down from 4.6%. This rate dropped again in 1990 to an estimated 3.0%. The rate for the remaining group of OECD countries moved up in 1989 to 3.8% from 3.4% the year before. Growth for this group is estimated to be down to 2.5% in 1990, lower than for the major industrial countries. The rate is projected to move up slightly to 2.7% in 1991.

These are the major industrial countries of the world. And it should be noted that industrial activity tends to be more energy-intensive than many other aspects of economic activity and therefore growth in these countries stimulates energy demand.

Economic growth in the developing countries is estimated to have slowed slightly in 1989 to 3.3%, down from 4.2% the year before. But the growth rate is estimated to have moved back up in 1990 to 4.2%. Low oil prices and energy costs are particularly stimulating to economic growth in the developing countries, which do not have as many alternatives to help fuel their economies or the funds to invest in energy conservation.

Although lower energy prices helped the oil-importing developing countries, they have had a less stimulating impact on the oil exporting countries. Energy-exporting developing countries have, until recently, accounted for around 40% of the combined economic activity of the developing countries. The energy- exporting countries had an average economic growth rate of about 6.6% from 1971 to 1980. But from 1981 to 1989 the growth rate averaged only 0.85%. Economic growth in these countries is estimated at 2.9% in 1990. For the non–energy-exporting developing countries the growth rate was 5.2% in 1988 and an estimated 3.7% in 1989. It is estimated at 4.7% in 1990.

The depressing impact of huge budget deficits, huge worldwide debt and growing protectionism has been offsetting the favorable stimulus of lower energy prices. All of the former factors tend to slow economic growth. However, if these factors are kept under control without stimulating another round of worldwide inflation, prospects for continued worldwide economic growth would be good.

A major key to economic growth is the level of investment. Investment can be stimulated if inflation is kept under control, and if the debt burden is managed properly including a slow reduction in debt levels.

This outlook is based on the expectation that these problems will not be eliminated but will be controlled and the world economy will continue to expand.

ENERGY. The relationship between economic growth and energy changed markedly after energy prices skyrocketed in the 1970s and early 1980s. Price-induced conservation reduced energy consumption throughout the industrial world. This was more pronounced in the years following the 1978–79 oil price hike.

From a worldwide perspective the effect of conservation on energy consumption was partially offset by continued growth in the developing areas in which conservation of energy has not been as evident as in industrial areas. In the developing areas, industrialization is still the major eco-

WORLDWIDE PRIMARY ENERGY CONSUMPTION

Country/Area	1979	1982	1985	1987	1988	1989	% change 89/79	% change 89/82
	(Million barrels oil equivalent)							
North America								
U.S.*	13,990.0	12,598.8	13,138.3	13,637.5	14,190.1	14,424.0	3.1	14.5
Canada*	1,625.8	1,575.2	1,633.1	1,716.7	1,802.4	1,790.7	10.1	13.7
TOTAL NORTH AMERICA	**15,615.8**	**14,174.0**	**14,771.4**	**15,354.2**	**15,992.6**	**16,214.7**	**3.8**	**14.4**
LATIN AMERICA	**2,426.2**	**2,705.5**	**2,883.6**	**3,121.1**	**3,193.7**	**3,324.2**	**37.0**	**22.9**
Western Europe								
Austria*	193.5	178.9	184.7	199.4	195.0	195.0	0.8	9.0
Belgium & Luxembourg*	374.6	337.2	352.6	376.0	379.7	373.8	– 0.2	10.9
Denmark*	147.3	122.4	134.9	132.7	131.9	120.2	– 18.4	– 1.8
Finland*	158.3	156.9	165.7	178.1	175.2	174.5	10.2	11.2
France*	1,414.0	1,332.6	1,382.4	1,452.1	1,444.7	1,476.3	4.4	10.8
Greece*	127.5	123.1	139.3	153.2	159.8	162.0	27.1	31.6
Iceland*	13.9	11.0	11.0	11.7	11.7	12.5	– 10.1	13.6
Republic of Ireland*	65.2	60.8	62.3	64.5	64.5	66.7	2.3	9.7
Italy*	1,097.3	1,029.9	1,023.3	1,090.7	1,113.4	1,136.2	3.5	10.3
Netherlands*	575.4	496.2	510.9	541.7	545.4	544.6	– 5.4	9.8
Norway*	232.4	237.5	234.6	243.4	242.6	240.4	3.4	1.2
Portugal*	82.8	90.9	78.4	87.2	88.0	96.8	16.9	6.5
Spain*	552.7	554.9	571.0	589.3	609.1	634.8	14.9	14.4
Sweden*	365.8	338.6	392.2	394.4	418.5	406.1	11.0	19.9
Switzerland*	179.6	188.4	209.6	208.2	210.4	197.9	10.2	5.0
Turkey*	171.5	203.0	228.0	348.2	364.3	377.5	120.1	86.0
United Kingdom*	1,626.5	1,421.3	1,481.4	1,515.8	1,523.9	1,494.6	– 8.1	5.2
West Germany*	2,103.7	1,829.6	1,962.2	1,956.4	1,970.3	1,922.7	– 8.6	5.1
TOTAL WESTERN EUROPE	**9,482.0**	**8,713.2**	**9,124.5**	**9,543.0**	**9,648.4**	**9,632.6**	**1.6**	**10.6**
U.S.S.R. and Eastern Europe								
U.S.S.R.	8,312.2	8,638.4	9,446.9	9,957.8	10,188.0	10,184.3	22.5	17.9
Eastern Europe	3,257.5	3,260.4	3,429.0	3,560.2	3,526.5	3,467.8	6.5	6.4
TOTAL U.S.S.R. AND EASTERN EUROPE	**11,569.7**	**11,898.8**	**12,875.9**	**13,518.0**	**13,714.5**	**13,652.1**	**18.0**	**14.7**
CYPRUS/GIBRALTAR/MALTA	**11.0**	**11.7**	**14.7**	**17.5**	**19.1**	**18.3**	**66.4**	**56.4**
MIDDLE EAST	**951.4**	**1,070.9**	**1,357.5**	**1,495.3**	**1,617.0**	**1,689.6**	**77.6**	**57.8**
AFRICA	**1,106.1**	**1,337.0**	**1,419.8**	**1,467.5**	**1,549.6**	**1,582.5**	**43.1**	**18.4**
Asia								
China	3,250.9	3,186.4	3,972.1	4,341.6	4,516.7	4,870.8	49.8	52.9
Japan*	2,711.4	2,499.5	2,743.6	2,786.1	2,949.6	3,059.5	12.8	22.4
South Korea	278.5	302.0	380.4	488.2	551.2	601.1	115.8	99.0
Taiwan	151.7	174.5	243.4	291.0	327.7	343.0	126.1	96.6
South Asia	784.3	1,002.7	1,235.8	1,391.2	1,505.6	1,580.3	101.5	57.6
Other Asia	962.4	997.6	1,029.9	1,168.4	1,252.7	1,373.6	42.7	37.7
TOTAL ASIA	**8,139.2**	**8,162.7**	**9,605.2**	**10,466.5**	**11,103.5**	**11,828.3**	**45.3**	**44.9**
Australasia								
Australia*	527.8	549.0	578.3	642.8	613.5	664.1	25.8	21.0
New Zealand*	82.1	84.3	97.5	113.6	118.0	131.2	59.8	55.6
TOTAL AUSTRALASIA†	**609.9**	**633.3**	**675.8**	**756.4**	**731.5**	**795.3**	**30.4**	**25.6**
TOTAL WORLD	**49,911.3**	**48,707.1**	**52,728.4**	**55,739.6**	**57,569.9**	**58,737.6**	**17.7**	**20.6**
OECD	**28,419.1**	**26,020.0**	**27,315.2**	**28,439.7**	**29,322.2**	**29,701.1**	**4.5**	**14.2**

*OECD (Organization of Economic Cooperation & Development) member.
†Includes Australia and New Zealand

Source: British Petroleum

nomic policy objective and supersedes any attempts at conservation. But in these areas, higher energy prices slowed economic growth and therefore also resulted in lower energy consumption.

There has been a shift in this trend the past couple of years. The lower energy prices have helped slow conservation and the search for a more efficient use of energy. And the ratio of energy consumption to economic growth has moved up.

Over the long run the ratio of energy to gross economic output can be expected to continue to fall worldwide, and particularly in the industrial areas. However, lower energy prices would slow conservation efforts and slow the rate of change in this ratio. This would be particularly

true in those areas where lower energy costs are passed through to the user or consumer of energy. The current situation in the Middle East, however, makes it difficult to estimate the future trend in the cost of energy.

World primary energy consumption has been on the rise in recent years. Total world primary energy consumption moved up 2.5% in 1986, to 54.1 billion barrels of oil equivalent. It moved up another 3.1% in 1987, to 55.7 billion barrels of oil equivalent, and then jumped up another 3.3% in 1988, to 57.6 billion barrels of oil equivalent. In 1989 this increased again, up 2.0% to 58.7 billion barrels.

World primary energy consumption moved up steadily through the 1950s, 1960s and 1970s, to 49.9 billion barrels of oil equivalent in 1979. During the ten-year span, 1969–1979, world energy consumption increased 51.6%, or at an average annual rate of about 4.2% per year. However, following the sharp increase in energy costs in the 1970s and early 1980s, a conservation effect was felt and energy consumption leveled off and fell. Energy consumption fell 2.4% between 1979 and 1982 to a recent low of 48.7 billion barrels of oil equivalent.

As energy prices began to slide, consumption increased, moving up steadily since 1982. Still lower energy prices and more vigorous economic growth helped boost energy consumption another 4.4% in 1984. It moved up in 1985, 2.4%, to 52.7 billion barrels.

Most of the energy conservation took place in the non- communist countries. During the period 1979 through 1982, energy consumption fell 4.3% in the non-communist countries. Over the same three-year span, energy consumption in the communist countries moved up 1.9%. With the extensive network of controls, world prices had a lot less impact on energy consumption in the countries with centrally planned economies.

Energy consumption in the non-communist countries began to move up again as prices moderated, increasing 0.6% in 1983. It moved up 4.4% in 1984, 1.6% in 1985, 2.1% in 1986, 3.5% in 1987, 3.9% in 1988 and 2.2% in 1989. Since the recent low in 1982, energy demand has increased 20.6% through 1989.

The conservation effect had the biggest impact on the industrial countries with energy-intensive economies. Between 1979 and 1983, U.S. energy consumption fell 10.2%, Western Europe energy consumption fell 8.1% and Japanese energy consumption fell 7.8%. Most of these countries were highly dependent upon oil to fuel economic growth, and the huge increase in oil prices provided substantial incentive for conservation.

Even with moderately lower energy prices, growth in energy consumption has been modest in these industrial areas. But the rate of growth has been picking up in some of the areas. North American energy consumption moved up 5% from 1982 to 1986, then jumped up 2.9% in 1987, 4.5% in 1988 and 1.4% in 1989. Japan's energy use was up 5.9% in 1988 and 3.7% in 1989. It had moved up 10.4% from 1982 to 1987.

In contrast, Western Europe's energy consumption was up only 1.1% in 1988 and fell 0.2% in 1989. It had moved up 9.2% from 1982 to 1987. Many countries in Western Europe tax energy heavily and the drop in energy prices is not always passed through to the consumer.

The combination of an increase in overall economic activity and low energy prices would ordinarily boost energy consumption in the near future. However, the current conditions are chaotic and this may not lead to low energy prices. Conservation will continue to dampen demand, but this should be offset by the effect of lower prices and economic growth. Lower energy prices should severely diminish the incentive for conservation and boost energy consumption. Higher prices should lead to increased conservation and lower energy consumption.

There has been a substantial shift in the market share of the various forms of primary energy. Over the period 1972 through 1983, oil's share

of total worldwide primary energy fell from 46% to 40.3%. It then dropped to 39.1% in 1984, and 37.8% in 1985. Lower oil prices helped boost it back up to 38.2% in 1986. Oil's share slipped to 37.9% in 1987 but recovered to 38.9% in 1988 and 38.7% in 1989. The lower oil prices have slowed the decline in market share but have not stopped it completely.

Although there have been year-to-year fluctuations in relative market shares, all other primary fuels gained market share at the expense of oil over the period 1972–85. The sharp drop in oil prices in 1986 and 1988 changed this trend slightly.

Natural gas moved up from 18.6% in 1972 to 20.0% in 1984, and 20.1% in 1985. The natural gas share slipped to 19.6% in 1986, but then moved back up to 20% in 1987, 20.9% in 1988 and 21.3% in 1989. Coal increased from 28.9% in 1972 to 30.1% in 1984 and 30.6% in 1985. Coal slipped to 30.5% in 1986, and then to 30.1% in 1987, 28% in 1988 and 27.8% in 1989. Nuclear power supplied only 0.7% of total energy in 1972 but has moved up steadily since, to 4.0% in 1984, 4.6% in 1985, 4.9% in 1986, 5.2% in 1987, 5.5% in 1988 and 5.6% in 1989. Nuclear's increase has not been affected much by the rise and fall in oil prices. Hydroelectric power contributed 5.8% in 1972, 6.8% in 1984, and 6.9% in 1985. It slipped to 6.8% in 1986, moved back up to 6.9% in 1987, fell to 6.7% in 1988 and 6.6% in 1989. Hydroelectric output is very dependent upon weather conditions and is expensive to develop.

The rapid rise in the price of oil relative to other fuels led to fuel switching. This was particularly true for heavy industry and electric utilities. With the high price, oil became the "swing fuel," supplying energy when other fuels were not available. Total world energy consumption was up 43.7% over the 1972–88 period, while energy from oil was up only 17.7%.

The rapid rise in oil prices made the consumers, worldwide, oil energy cost-conscious. Where possible, fuel switching to less costly fuels took place. In general, energy costs had risen enough to become a major concern in the operating economics of industrial production and in the cost of living, and substantial price-induced conservation took place.

The drop in crude prices in 1986 and 1988 made oil more competitive with other fuel sources and also slowed investment in conservation. If prices remain low in future years, oil's share of the market may even increase, replacing coal or natural gas in certain areas.

OIL PRODUCT DEMAND. Worldwide non-communist demand for oil products has gone through three phases over the past seventeen years. It followed two distinct trends between 1972 and 1983. From 1972 through 1979, free-world demand was on the rise, increasing 15.8% over this seven-year span. From 1979 through 1983, demand for oil fell as price-induced conservation took over. Consumption dropped 11.8% over this four-year time period. The net effect was that free-world demand in 1983 was only 2.2% above 1972.

There was a reversal of this downward trend in 1984 as lower prices and economic activity boosted demand 1.6%. Demand moved up only 0.2% in 1985, but then moved up 2.8% in 1986, 1.8% in 1987, 2.8% in 1988 and 1.5% in 1989.

This could signal the start of a new long term upward trend in oil demand. Lower oil prices, particularly real oil prices adjusted for inflation, are expected to combine with increased economic activity to boost demand throughout the near future.

A major factor lowering demand in the early 1980s was price- induced conservation, which brought about increased oil-energy efficiency. In addition, fuel switching, due to the higher oil prices, had an impact. They both helped to reduce overall demand for petroleum products, and also changed the mix of petroleum products consumed. There was a shift to a higher percent-

WORLDWIDE PETROLEUM PRODUCT CONSUMPTION

	1973	1976	1979	1982	1985	1988	1989	% change 79/73	% change 89/79	% change 89/73
	(Million barrels)									
U.S. and Canada	6,609.5	6,657.8	7,022.9	5,705.7	5,792.2	6,355.8	6,372.7	6.3	−9.3	− 3.6
Gasoline	2,487.8	2,565.5	2,619.0	2,366.1	2,441.6	2,641.0	2,646.1	5.3	1.0	6.4
Middle distillates	1,663.2	1,712.3	1,893.3	1,537.1	1,663.9	1,853.8	1,871.3	13.8	− 1.2	12.5
Fuel oil	1,214.6	1,201.4	1,198.5	737.4	534.4	609.1	604.0	− 1.3	−49.6	−50.3
Other	1,243.9	1,178.7	1,312.1	1,065.1	1,152.3	1,249.8	1,251.2	5.5	− 4.6	0.6
Western Europe and Japan	7,461.9	6,954.0	7,181.9	5,832.5	5,650.7	6,000.3	6,043.6	− 3.8	−15.8	−19.0
Gasoline	1,285.7	1,285.7	1,396.4	1,250.5	1,298.1	1,441.1	1,479.9	8.6	6.0	15.1
Middle distillates	2,196.1	2,144.0	2,300.2	1,976.9	2,107.4	2,321.4	2,309.0	4.7	0.4	5.1
Fuel oil	3,023.6	2,668.1	2,545.0	1,738.7	1,321.6	1,242.4	1,239.5	−15.8	−51.3	−59.0
Other	956.5	856.1	940.4	866.4	923.6	995.4	1,015.2	− 1.7	8.0	6.1
Rest of World*	3,008.2	3,346.1	4,042.5	4,344.5	4,538.0	5,076.8	5,327.4	34.4	31.8	77.1
Gasoline	574.7	622.3	768.9	853.9	915.5	984.4	1,040.1	33.8	35.3	81.0
Middle distillates	872.3	1,093.6	1,356.8	1,574.5	1,731.3	1,950.5	2,045.8	55.5	50.8	134.5
Fuel oil	1,136.9	1,158.1	1,369.2	1,309.1	1,226.3	1,325.3	1,405.9	20.4	2.7	23.7
Other	424.3	472.1	547.6	606.9	664.8	818.8	835.6	29.0	52.6	96.9
Total World*	17,079.6	16,958.0	18,247.3	15,882.6	15,980.9	17,432.9	17,743.7	6.8	− 2.8	3.9
Gasoline	4,348.2	4,473.5	4,784.3	4,470.6	4,655.3	5,066.5	5,166.2	10.0	8.0	18.8
Middle distillates	4,731.6	4,949.9	5,550.3	5,088.5	5,502.6	6,125.7	6,226.1	17.3	12.2	31.6
Fuel oil	5,375.1	5,027.6	5,112.7	3,785.2	3,082.3	3,176.8	3,249.4	− 4.9	−36.4	−39.5
Other	2,624.7	2,506.9	2,800.1	2,538.4	2,740.7	3,063.9	3,102.1	6.7	10.8	18.2

*Excludes communist areas Source: British Petroleum

age of light products since there was no convenient alternative energy substitute for these. The heavier fuel oils ran into a number of less costly substitutes that could be used, natural gas and coal being the major competing fuels.

The competition is most intensive for fuel for electric power consumption and for industrial production. Therefore, the impact of competitive fuels is most evident in the consumption of heavy fuel oil. Consumption of heavy fuel oil in the noncommunist world was 5.1 billion barrels in 1979. Demand fell 38.8% to 3.1 billion barrels in 1985.

The high prices for heavy fuel oil led to increased consumption of coal and in some areas, natural gas. These fuels replaced high cost heavy fuel oil. In addition, the nuclear industry continued to grow, displacing demand for heavy fuel oil for electric power consumption. Sharply lower prices in 1986 proved that there is still a market for heavy fuel oil if the cost is competitive. Total noncommunist consumption increased 2.7% in 1986 as low prices enabled heavy fuel oil to regain some market share from coal and natural gas. Prices moved back up in 1987 and demand fell again 3.4%. Prices fell in 1988 and demand increased 3.7%. Demand continued to move up again in 1989, 2.3%.

This consumption pattern was mainly due to demand in the United States. In the United States heavy fuel oil consumption fell 58.1% between 1977 and 1985. But demand rebounded in 1986, moving up 18%. Demand slipped again in 1987, falling 10.9%. With lower prices again in 1988 demand moved back up 9.4%. Slightly higher 1989 prices led to lower U.S. demand in 1989, falling 3.2%.

Demand for heavy fuel oil in Western Europe fell 50.5% between 1976 and 1985. But consumption moved up 0.5% in 1986 on the strength of economic growth and lower prices. Demand slipped 5.9% in 1987 as prices moved back up, and then continued to slide in 1988, down 3.9% and in 1989, down 1.4%. Consumption in Japan continued to slide throughout 1986 and 1987, down 5.1% and 3.6%. But in 1988 consumption reversed the trend and moved up 8.6%. The growth continued in 1989 up 1.9%.

Lower fuel oil prices made fuel oil more

competitive with other forms of energy. If prices of fuel oil remain competitive, there may actually be an increase in the demand for fuel oil in the future as the industrial countries look for a fuel source for increased electric power generation. The key to the level of demand will be the level of prices relative to other competing fuels.

The changing pattern of demand wasn't quite as dramatic for the other major petroleum products. Gasoline consumption in the non-communist world hit a high in 1978 at 4.8 billion barrels. With higher prices, demand fell rapidly, 6.9% to 4.4 billion barrels in 1982. But as prices slipped and economic growth continued, demand moved back up steadily from 1982 through 1989. Demand in 1989 was 5.2 billion barrels, up 15.6% from 1982. Demand in 1989 was 2.0% above 1988.

Demand in the U.S. also peaked in 1978 and then fell rapidly, 13% by 1982. Consumption in 1989 was up a marginal 0.1% from 1988 and up 11.3% from the recent low in 1982.

The pattern in Europe was similar. Gasoline consumption peaked in 1979, and then dropped abruptly, 9.1% by 1981. Demand has moved back up steadily since 1981. It moved up 1.7% in 1989 from 1988, and was 16.2% above 1981.

In the developing countries, gasoline demand continued to climb steadily throughout the 1970s and 1980s with only a slight slip in 1983 and 1984 due to the high prices. In-these areas demand moved up 6.0% in 1989 and was at a record high.

Middle distillate has been on the rise since 1982. Non- communist consumption increased 3.9% in 1986, 2.1% in 1987, 4.7% in 1988 and 1.6% in 1989. All four years surpassed the previous peak year of 1979. Middle distillate demand slid 8.6% between 1979 and 1982. But with increased economic activity and more reasonable prices, middle distillate demand has been increasing over the years since 1982.

Consumption of all other petroleum products moved up 1.2% in 1989 to 3.1 billion barrels. Demand in 1989 was at a new record high.

As can be seen, there has been a major shift in petroleum product demand to a larger percentage of lighter products. The major reason has been the reduction in demand for fuel oil. But in addition, demand for middle distillates, motor gasoline and other products has moved up along with economic growth.

Demand for petroleum products in the non-communist world peaked in 1979 at 18.2 billion barrels. This fell 12.4% to 16.0 billion barrels in 1985. The drop in fuel oil consumption accounted for 89.6% of the decline.

Total demand in 1989 was down 504 million barrels from the 1979 peak. Fuel oil demand in 1989 was down 1,863 million barrels, accounting for more than the entire decline.

From a geographical perspective, the shift in product mix is most pronounced in the United States, Western Europe and Japan. In these areas there has been a major shift away from fuel oil and an increase in demand for gasoline and middle distillates. In the rest of the free world, the shift has not been as pronounced, but is also evident.

Over the period 1977 through 1989, the product demand mix changed markedly. In the U.S., the fuel oil share of the total barrel dropped from 18.6% in 1977 to 9.3% in 1989. Gasoline moved up from 38% in 1977 to 42.2% in 1989. And middle distillates increased from 25.9% to 29.2% in 1989.

In Canada, the fuel oil share slipped from 18.5% to 11.8% in 1989. But fuel oil consumption had been lower and increased 22.2% in 1989. Gasoline consumption increased from 34.8% in 1977 to 35.0% in 1989. And the middle distillates share has remained fairly constant at 31.3% in 1977, and 31.2% in 1989.

In Western Europe and Japan, the drop in fuel oil demand was even more pronounced. In Europe, fuel oil demand dropped from 32.4% of the market in 1977 to 17.9% in 1989. Gasoline in

Europe moved up from 19.1% to 25.8% in 1989. And middle distillates shifted from 35.3% to 39.8%. In Japan, fuel oil fell from 49.5% of oil product consumption in 1977 to 27.0% in 1989. Gasoline moved from 17.1% to 21.3%, and middle distillates from 21.4% to 34.1% in 1989.

There are obvious geographical differences, with gasoline being a much greater share of the North American market, and fuel oil relatively more important elsewhere but diminishing in importance.

Looking at product consumption from the geographical perspective, what also stands out is the difference in trends between the industrial countries and the other, less-developed, countries (LDCs).

Total major product consumption in the United States, Canada, Western Europe, and Japan dropped 12.6% from 1979 through 1989. For the remainder of the non-communist world, consumption in 1989 was up 31.8% from 1979.

PRICES. As was mentioned previously, there was an abrupt alteration of the relationship between economic activity and energy consumption, starting in the 1970s. This alteration was primarily due to the rapid increase in the cost of oil and other energy in the 1970s.

Oil, and other energy costs, increased more rapidly than other economic costs. This made energy cost a more important consideration in business decision-making. The result was an adjustment in investment decisions with more concern for cost-cutting and energy-saving investments.

This shift altered the emphasis of investment decisions; from investing for increased economic output for consumption, to an emphasis on energy cost-cutting. This contributed to a drop in energy demand, but also slowed worldwide economic growth.

From 1972 to 1982, the posted price of Saudi Arabian marker crude increased from $2.48/bbl to $34/bbl, an increase of 1,271% or $31.22/bbl. The real price adjusted for inflation increase 546%. This far surpassed the average price increase for all commodities of 151% over this period.

The sharp increase in prices did not initially slow demand for petroleum products. There is some evidence that the price of crude oil was held below the market equilibrium price in the 1960s. This made oil cheap relative to other items and this stimulated demand. Therefore, the initial 1973–74 increase in oil prices was relatively easily absorbed by the economy.

Another reason that demand did not appear to react to the initial price increase is that many energy and oil conservation investments take time to exert a measurable impact. In the industrial, utility and residential/commercial sectors, it may take up to 10 years or more before the majority of the impact from conservation investment is felt.

The time it took to adjust to the price shock varied in the different economic sectors. In the electric utility and heavy industry sectors, the total adjustment was slower although still dramatic. In these sectors, conservation or fuel switching often requires a substantial capital investment.

On the other hand, adjustment to price changes can be very rapid in the transportation sector of the economy. Much of the conservation is in the form of a change in discretionary driving habits. But there are also fewer substitutes for petroleum products in this sector and therefore limits on fuel switching. This can offset some of the potential impact on energy demand from higher prices.

Current dollar prices leveled off after the initial price shock of 1973–74, and the real inflation-adjusted price fell. This muted the conservation adjustment to this price hike.

The 1979–80 price boost produced a much more dramatic adjustment. That price jump coupled with forecasts of future rapidly rising oil prices led to a sharp drop in oil consumption.

Between 1978 and 1981, the world price of oil jumped another 152%. Responding to this rapid increase in prices, the demand for oil in the non-communist world peaked in 1979 and dropped 12.3% by 1983. Over this four-year period, the worldwide demand response to the price increase was a 0.9% drop in demand for every 10% increase in price. This is relatively inelastic demand. But it did show that there was a demand response to price that must be considered when estimating demand for oil products.

The drop in oil demand as a response to prices, and the worldwide economic slowdown, put downward pressure on crude prices in the early 1980s. When demand fell sharply, a massive crude production capacity surplus developed. The surplus led to intense price competition in the oil market. And the result was a peaking of crude prices in March 1981. Although the official price of the OPEC marker Saudi light crude was boosted to $34/bbl in 1982, actual average transaction prices for crude oil traded were falling starting in March 1981.

The Saudi light crude marker price was lowered to $29 in early 1983, and again to $28 at the beginning of 1985. This was a 17.6% drop in the official marker crude price. The drop in actual transaction prices was even greater as more and more crude oil was being traded based on spot market prices.

Initially, the lower crude oil prices had a small positive impact on demand in the non-communist countries. Demand moved up 2.0% in 1984, but slipped 1.1% in 1985.

It should be noted that the strong U.S. dollar at that time relative to other currencies resulted in oil prices being higher outside the U.S. Export crudes, particularly from OPEC, are denominated in U.S. dollars. Therefore in several European countries, oil prices and petroleum product prices had actually risen from 1981 to 1985. That tended to suppress demand for petroleum products in Europe and other areas and was a major reason why the demand response wasn't greater worldwide.

Prices were prevented from falling even more rapidly in the 1981–85 period by the willingness of Saudi Arabia to support prices through a reduction in their production level. But there was a limit to the extent Saudi Arabia would support prices.

One of the most significant recent pricing events occurred in late 1985. Saudi Arabia became alarmed when their production fell below 2 million b/d, playing the role of swing producer to prop up prices during declining demand for OPEC oil. They were not getting cooperation from other OPEC countries in cutting production to support prices.

So, in the fall of 1985, Saudi Arabia abandoned their role of crude exporter of last resort or swing producer, deciding to concentrate on maintaining a "fair share" of the market. They adopted a net-back pricing scheme that enabled them to recapture a substantial share of the export market for crude oil.

OPEC, in December 1985, adopted a similar policy objective of capturing world market share by price competition. These two moves flooded the world market with excess oil, and created more downward pressure on prices.

As soon as the winter demand for oil slackened in January 1986, prices began to plummet. The average worldwide price of exported crude oil fell from $27.10/bbl the first week of January 1986 to $9.35/bbl the first week of August 1986. This was a drop of $17.75/bbl, 65.5% in seven months. This forced OPEC to put together an informal quota agreement effective in September 1986. And that helped prices move back up to $13–14/bbl throughout the remainder of 1986. A formal OPEC quota agreement followed in December and helped push average export prices up over $17.50/bbl in 1987. Futures market prices, which are based on one high grade of light sweet crude, moved over $20/bbl.

As mentioned, oil product demand is relatively price inelastic. But a drop in price of the

magnitude that occurred in 1986 is sure to have a stimulative impact on demand and offset some conservation.

As a result, non-communist world demand for petroleum products moved up 3.3% in 1986. Demand in the U.S. moved up 3.5%. Demand in Western Europe moved up 4% in 1986. Even in Japan, where oil conservation is a major economic objective, oil demand moved up 0.9% in 1986.

Prices moved back up in 1987 but were still much lower than in the recent past. And this relatively low price level had a mildly stimulative impact on demand. Total non-communist demand increased 2% in 1987.

Prices slipped again in 1988 due to OPEC overproduction. Although OPEC has a quota system in place, a number of the member countries, notably Iraq and the United Arab Emirates, refused to adhere to the quotas and boosted output. This overproduction weakened prices and by October 1988 crude prices had dipped close to the low level of 1986.

This tended to stimulate demand again and non-communist consumption moved up 3.9% in 1988.

Prices in 1989 were very similar to 1987, holding relatively constant as OPEC managed to hold production close to a market clearing level. Prices in 1989 were up about 20% from the year before which tended to dampen somewhat the increase in petroleum product demand. But demand in the non-communist areas did move up 1.8%, primarily due to growth in the developing countries.

There appeared to be a price cycle developing that was driven by OPEC production. There was a tendency on the part of the OPEC cartel to overproduce the production quotas they set. There was apparently some tendency for the individual OPEC countries to compete for market share when demand began to rise. This led to production well above the quota level set for OPEC.

The excess production puts downward pressure on prices. When prices fall to a level that the OPEC countries feel is unacceptable, a new quota agreement is reached. Some production discipline is practiced for a period of time and prices move back up closer to the OPEC target level.

However, at these relatively low price levels demand continues to move up and market share competition starts up again. And the cycle starts to repeat itself.

This cycle might have gone on for a considerable period of time. However, the recent crisis in the oil producing areas of the Middle East may have substantially altered the relationships between OPEC supply and worldwide demand that created the cycle.

OUTLOOK

The invasion of Kuwait by neighboring Iraq in early August 1990 has had a substantial impact on the demand-supply relationship in the worldwide petroleum industry. These two countries together were producing around 4.7 million b/d at the time of the invasion. The subsequent embargo of crude oil from Iraq and Kuwait removed close to 4.2 million b/d in exports from these two countries. In addition, 300,000 b/d of production from the Kuwaiti share of the Neutral Zone was also affected by these events.

The sharp reduction in worldwide crude oil supply had an almost immediate impact on crude oil prices. Prices were on the rise before the invasion, but moved up sharply after. The average price of world export crude oils increased 50% in the three weeks following the invasion. Prices on the futures market moved up over $30/bbl and hit the highest level since 1985.

There is no way to determine if the sharp rise in prices has had an impact on demand for petroleum products. However, it is fairly safe to assume that an increase in oil prices of that magnitude will have a substantial impact on demand.

The impact will go beyond the demand for petroleum products. If oil prices remain higher for an extended period, other energy costs will begin to move up as fuel substitution increases the demand for other fuels. The resulting increase in energy costs will have an impact on economic growth.

At this time it is uncertain how long the crisis involving Iraq and Kuwait will last. It is quite probable that the loss of this volume of crude oil will exert upward pressure on crude oil prices as long as the crisis continues. This makes it almost impossible to project with any certainty the most likely trend in economic growth, energy demand and demand for petroleum products.

Therefore, for the first time in this edition of the *Oil Industry Outlook*, three Scenarios are being presented. The three scenarios vary in expectations of the length of time the crisis in the Persian Gulf will last. The length of time the oil crisis continues will have an impact on the price of crude oil, the cost of energy, the rate of economic growth, the level of energy consumption and the level of petroleum product demand. To cover these variations three separate forecasts are presented. The forecast with the highest degree of probability is the one that comes closest to the length of time it takes to finally resolve this issue in the Middle East, and for Iraqi and Kuwaiti oil to return to the market.

Scenario I—The situation in the Middle East lasts for an extended period. The embargo of oil exported from Iraq and Kuwait continues for a period of 6–18 months. The vast majority of oil production in Iraq and Kuwait is shut in for the duration of the dispute. Production and exports from the Kuwaiti half of the Neutral Zone are also curtailed during this period. Oil production capacity in other OPEC areas is not affected by the dispute. Following the settlement of the dispute, production in Iraq and Kuwait is resumed at levels close to the production levels prior to the invasion.

Scenario II—The situation in the Middle East lasts for an even longer time period than in Scenario I. The embargo of oil exported from Iraq and Kuwait continues for a period of 18–30 months. The vast majority of oil production in Iraq and Kuwait is shut in for the extended duration of the dispute. Production and exports from the Kuwaiti half of the Neutral Zone are also curtailed during this period. Oil production capacity in other OPEC areas is not affected by the dispute. Following the settlement of the dispute, production in Iraq and Kuwait is resumed at levels close to the production levels prior to the invasion.

Scenario III—The situation in the Middle East lasts for a relatively short period of time. The embargo of oil exported from Iraq and Kuwait continues for less than six months. The vast majority of oil production in Iraq and Kuwait is shut in during this period. Production and exports from the Kuwaiti half of the Neutral Zone are also curtailed during this short period. Production capacity in other OPEC countries is not affected by this dispute. Following settlement of the dispute, production in Iraq and Kuwait is resumed at production levels close to those prior to the invasion.

The major differences between the three scenarios is the length of time that the crisis continues and Iraqi and Kuwaiti oil is off the market. But even though the length of time until settlement of the dispute is the only apparent difference, these three scenarios will cause three distinct sets of conditions in the oil market. And the different market conditions will create differing projections of demand for energy and petroleum products over the forecast period, 1991–95.

The disruption of oil production and oil exports from Iraq and Kuwait will have an immediate impact on crude oil and petroleum product prices. And it is expected that the loss of this oil will tighten the market and place upward pressure on prices while the crisis lasts. Prices will fluctuate with seasonal demand because requirements for OPEC oil will come close to capacity during the periods of peak demand. As demand approaches capacity, prices will be bid up by refiners and traders looking for supplies to meet winter

demand.

With the elimination of supplies from Iraq and Kuwait, a substantial portion of the OPEC excess capacity has been eliminated. Therefore as long as that production remains shut in, the crude oil market will be tight, with little contingency production capacity available. Prices will remain much higher than they would be if this capacity was available to the market.

SCENARIO I—under this scenario, prices will remain inflated during the next 6 to 18 months until the dispute is settled in the Middle East. Prices have already increased substantially and it is estimated that the average price of world export crude will be up 20% in 1990 at an average of 20/bbl for the year. With the tight supply situation, prices will increase another 25% in 1991 to an average of $25/bbl. It is assumed under this scenario that the Iraq-Kuwait dispute will be settled around the first part of 1991 and this oil will be returned to the market. There will be a return to a situation of excess OPEC capacity, which will result in downward pressure on prices. The average price for world export crudes will fall 22% to $19.50/bbl in 1991. For the remainder of the forecast period 1992–95, prices will move up gradually due to increased demand. The average price will increase to $22.50/bbl in 1995. Prices will not return to the level reached under the shortage conditions that prevailed in 1991.

SCENARIO II—under this scenario, oil prices will remain inflated for an extended period of 18 to 30 months. Crude prices will move up to $25/bbl in 1991 as in Scenario I. With the Iraq-Kuwait production still shut in during 1992, prices will continue to move up, averaging $27.50/bbl for that year. It is assumed that the conflict will be resolved around the end of 1992 or early 1993 and that the production and exports from Iraq and Kuwait will re-enter the market. This additional capacity will result in excess capacity in 1993 and downward pressure on prices. The average price of world export crude will drop sharply, down 31% to $19/bbl. There will be additional downward pressure under this scenario. Lower demand due to high product prices in 1991 and 1992 will have an impact on the market clearing prices.

Coupled with this, there will be additional capacity developed during the high prices years to help make up for the shortage, which also will contribute to the downward pressure on prices. Prices will move up gradually during the remainder of the forecast period 1994–95, reaching $22/bbl in 1995. Prices at the end of the forecast period will end up lower than under Scenario I because of slower economic growth, lower petroleum product demand and additional crude production capacity.

SCENARIO III—under this scenario, the dispute in the Middle East will be resolved by the end of 1990 or early 1991. The lost production and exports from Kuwait will have an impact on the market in the latter half of 1990 but not in the years following. Prices will move up in 1990 and average $19.50/bbl, an increase of 17%. However after the shut in production is returned to the market, prices will fall back to the expected longer term trend and average $18/bbl in 1991. The OPEC excess capacity will again have a moderating impact on prices. Over the remainder of the forecast period, crude prices will continue to move up and will average $23/bbl in 1995. Increased demand and a reduction of the excess capacity will put moderate upward pressure on prices.

It is expected that OPEC will continue to be a major factor in determining the worldwide prices for crude oil and therefore the worldwide demand for petroleum products once this dispute is settled. It is also expected that the OPEC countries with the largest reserves will have the most influence in setting OPEC target prices. OPEC's policy will again be to establish a market clearing production level that will result in a targeted price for their exported crude oil.

In the past, OPEC's inability or unwillingness to keep its production in line with the selected quota and product demand was the major reason for the volatility in prices. And price

volatility had an impact on product demand. This problem may plague OPEC and the oil market again, but it is expected that there will be more production discipline after the termination of the Iraq-Kuwait crisis. After the crisis ends, the situation will return to one in which there is excess production capacity. This should help keep prices relatively low. And the lower prices should stimulate product demand.

It is expected that inflation will average in the range of 3-4%/year over the forecast period. The modest rise in crude oil prices will mean that the real price of crude will remain fairly constant and may even decline once the Middle East crisis is resolved. This would be very stimulative to petroleum product demand. However, this is consistent with one of the key objectives of the OPEC countries with large reserves.

The level of economic activity will still be one of the major factors determining the level of energy demand and petroleum product demand. But the cost of energy is the factor determining the effort given to conservation. And the relative price levels greatly influence the type of energy that will be used to fuel the economic growth. Economic growth, energy demand, oil demand, energy prices, and oil prices are all interrelated and interdependent.

There are still a number of major problems that plague the worldwide economy. The major problems are the huge international debt, large budget deficits, rapid population growth and unemployment. And there is a growing threat that a wave of protectionism may sweep over the industrialized areas and reduce world trade. Any and all of these could slow worldwide economic growth.

These problems are being contained at the present time. And it is not anticipated that they will cause a recession during the next five years. However, the rapid rise in oil prices in 1990 and possibly continuing into 1991 and 1992, could substantially slow economic growth and possibly even lead to a recession.

SCENARIO I—It is expected that the growth in worldwide economic activity will slow in 1990 and be lower than expected due to the higher oil prices. The rate of growth will slow even more in 1991 falling to around 2% as oil and energy prices move up. With lower oil and energy prices in 1992, economic growth will rebound. Worldwide economic activity is expected to move up at a rate of around 2.7%/year for the remainder of the forecast period.

SCENARIO II—In this scenario, worldwide economic activity will follow a pattern very similar to Scenario I through 1991. However, in 1992 as oil and energy prices continue to move up the rate of growth in economic activity will slow even more. It is quite possible that there could be a recession in some countries. When oil prices fall in 1993 there will be a rebound in the rate of growth for the worldwide economy. For the remainder of the forecast period it is expected that economic activity will grow at a rate similar to Scenario I, close to 2.7%/year.

SCENARIO III—In this scenario, high oil prices are expected to slow the rate of growth in 1990 and into 1991. However, the rate of growth in 1991 will be higher than in Scenarios I and II. Since oil and energy prices are expected to return to lower levels in 1991, the rate of worldwide economic growth is expected to move up to over 3% in 1992. For the remainder of the forecast period economic growth under this scenario will average around 2.6%/year.

Once the dispute is resolved between Iraq and Kuwait, relatively low energy prices are expected to be a positive stimulus to economic activity throughout the remainder of the forecast period. There are a number of other events that could also give a positive stimulus to economic growth during the next five years. The establishment of the new economic rules for the European Economic Community in 1992 is expected to boost trade and economic activity. And the recent events In Eastern Europe and the U.S.S.R. could result in the development of more vigorous

economies with great growth potential. The relatively low oil prices and increased economic activity in the latter years of the forecast period is expected also to stimulate demand for petroleum products. And this in turn will enable a gradual price increase over those years. All of these elements are interrelated.

Looking at the long-term historical relationship of energy consumption to economic growth, it is expected that energy conservation will continue to some degree throughout the forecast period. Therefore the growth in energy demand will track the rate of growth of economic activity, but at a slower rate. However, during the years of relatively low energy prices it is expected that the ratio of energy growth to economic growth will be greater than in the recent past. With low cost energy there is not as much incentive to invest in conservation. Instead, energy is used more liberally to fuel economic growth.

During the years of low cost energy, investment in energy conservation will be lower than in past years, but it is still expected to continue to move up. There is now a great deal of concern about the impact of energy consumption on the environment. Therefore there will be a lot of pressure in the industrial world to improve on energy consumption efficiency.

SCENARIO I—Since growth in energy consumption will follow growth in economic activity, the pattern for the rate of energy growth will be similar to that outlined for economic growth. With higher oil and energy prices in 1991, economic growth will slow and the rate of increase in energy consumption will be lower. This will be particularly pronounced in the industrial OECD countries. When oil prices fall in 1992, the rate of growth in economic activity will increase and so will the rate of growth in energy consumption. Total worldwide demand for energy is projected to be up 9.1% at the end of the forecast period, 1995. The rate of increase will be somewhat higher in the developing countries where energy consumption is expected to be 13.4% higher in 1995.

SCENARIO II—In this scenario, energy consumption growth will also follow economic growth. Therefore energy demand growth will be quite modest in 1991 and 1992 due to the slower economic growth related to the sharp rise in oil and energy costs. The growth in energy demand will continue after the dispute is resolved and oil prices fall. However, sinc energy prices will remain high for a longer period of time, there will be greater investment in energy conservation. Therefore energy growth may not be as vigorous in the latter years of the forecast period as in the other two scenarios. Worldwide energy demand is expected to be up 8.3% at the end of the forecast period, 1995.

SCENARIO III—In this scenario, energy consumption will also follow the expected rate of growth in economic activity. Growth will be slowed a bit in 1991 due to the higher oil and energy costs at the end of 1990 and possibly continuing into early 1991. Since oil and energy costs will revert to their former relatively low level, there will be little incentive for a substantial increase in investment in energy conservation. By the end of the forecast period, 1995, worldwide energy demand will be up 9.8% in this scenario.

In the past there has been greater incentive to increase energy efficiency in the market economies than in the communist world. However, those countries are now adjusting their economies and creating market-oriented systems. As this transition gains momentum, these economies will begin to use energy more efficiently. In the three scenarios presented, the growth in energy consumption in the former communist areas is expected to move up at a rate slightly higher than in the industrial economies of the OECD. The rate of energy growth in those areas could be slowed because of a low rate of economic growth due to adjustment problems or

the development of more energy efficiency.

Once the Middle East dispute has been resolved, the relatively low current and real oil prices and petroleum product prices will help stimulate the worldwide demand for oil. And the rate of increase in oil demand will move up close to the rate of increase in overall energy demand. Oil consumption conservation is also expected to continue throughout the forecast period, but with lower energy prices the incentive is greatly reduced. With low prices, oil will be much more competitive with other fuels and will be able to retain or regain a good portion of its present share of the total energy market.

Demand for all major types of petroleum products, including fuel oil, is expected to increase over the forecast period in all of the scenarios. One of the things that will stimulate demand for petroleum is the growth in electric power consumption worldwide. At the lower prices, fuel oil will play the role of swing fuel for electric utilities and heavy industry and demand will increase.

SCENARIO I—Over the five-year forecast period, 1991–95, world oil demand is projected to increase 7.0% to 70.3 million b/d in 1995. This is an increase of 4.59 million b/d. OECD oil demand is expected to increase 5.2% to 39 million b/d in 1995. This will be an increase of 1.9 million b/d. Demand in the developing countries will increase 11.9% to 16.6 million b/d. This will be an increase of 1.765 million b/d. The rate of increase in demand will slow a bit in late 1990 and through 1991 due to the higher prices. However, demand will remain strong in the developing countries where there are few alternatives to oil. Therefore the growth in oil demand will not slow as much as might be expected from the sharp rise in prices. After the dispute is resolved and prices fall, oil demand will increase at a faster rate. But it will remain closely related to economic growth and the growth in total energy consumption.

SCENARIO II—The growth in oil demand will be slowed for a second year due to the high oil prices. Demand will move up at a faster rate when oil prices fall in 1993. Over the forecast period, annual average worldwide oil demand will increase 6.7% to 70.1 million b/d. This will be an increase of 4.4 million b/d. Demand in the OECD countries will increase 1.777 million b/d, 4.8%, to 38.875 million b/d. Demand in the developing countries will move up almost as much, increasing 1.75 million b/d, 11.8%, to 16.553 million b/d. Demand in the area of the Centrally Planned Economies will increase 6.4%, to 14.719 million b/d.

SCENARIO III—In this scenario, demand growth will be slowed slightly due to the high oil prices at the end of 1990 and possibly early in 1991. But since oil prices are expected to drop to former levels relatively soon, there will be little if any incentive to invest more in conservation. Average annual worldwide oil demand will move up 8.3% over the forecast period to 71.6 million b/d in 1995. Demand in the developing areas will move up 2.177 million b/d to 17.11 million b/d. The increase will be greater than in the OECD countries where demand will increase 2.091 million b/d to 39.299 million b/d in 1995.

In the areas covered by the OECD and LDCs (Less Developed Countries), demand for all major products is expected to increase over the forecast period in all three scenarios. Low prices over some part of the forecast period should even boost demand for heavy fuel oil in all of the scenarios. Fuel oil will be much more competitive with other fuels than in years of high oil prices. Growth in demand for fuel oil is not projected to be as rapid as for other petroleum products. However, the growth could be greater worldwide if there is any slowing in completion of nuclear facilities, or if coal usage is curtailed due to "acid rain" and other environmental concerns. These factors are becoming important global issues. They may prove to be more important determinants of oil demand in the future than the flare-up in the Middle East.

WORLDWIDE DEMAND KEYS TO THE FUTURE

SCENARIO I

1. The dispute in the Middle East between Iraq and Kuwait will continue for 6 to 18 months. The embargo on oil exported from these two countries will continue over this period. Most of the production in these two nations will be shut in over this period. This will result in substantially higher oil prices in 1991.

2. Prices will move up in 1991, increasing an additional 25% to $25/bbl due to the loss to the market of the substantial production and capacity in Iraq and Kuwait. When the dispute is settled, prices will fall sharply to $19.50/bbl in 1992. The sharp drop in prices will be due to the return to worldwide excess production capacity. It is expected that in the latter years of the forecast period, prices will move up gradually, along with increased demand for petroleum products.

3. No recession is expected during the forecast period, but a slowdown in the economic growth rate is expected in 1991 and into 1992 due to the higher oil prices. Europe 1992 is expected to give the worldwide economy a boost. The development of market economies in East Europe may also boost the worldwide economy later in the forecast period. Major problems with international debt, large budget deficits, unemployment, etc. will be contained. Population and environmental problems are expected to grow in importance.

4. After the dispute is resolved between the two OPEC countries, Iraq and Kuwait, the OPEC cartel will continue to have some influence over the worldwide oil industry. It is likely that the OPEC countries with large reserves will dictate oil policy. But OPEC will continue to have problems with controlling the overall production level, which will put some downward pressure on prices after the dispute it settled.

5. During the period of high energy prices there will be some incentive to invest in energy conservation. However, prices will not remain high long enough to result in a large investment. The relatively low oil and energy prices are expected to dampen the incentive for investing in energy conservation after prices fall. There will be continued improvement in energy consumption efficiency, but the rate of improvement will be slower.

6. The increased level of economic activity and relatively low oil prices will help stimulate demand for petroleum products. World demand for petroleum products is expected to increase over the forecast period. The rate of growth will be slower in 1991 due to the high prices. The growth rate in the developing countries will be greater than in the industrial areas.

7. Demand for distillate and special petroleum products will lead the way in the growth in product demand. But lower prices will also stimulate demand for gasoline and heavy fuel oil. Demand for heavy fuel oil could move up even more if environmental concerns slow growth of nuclear energy or coal consumption.

THE OUTLOOK — WORLDWIDE DEMAND
SCENARIO — I

	1989	1990	1991	1992	1993	1994	1995	Change 1990 to 1995	% change 1990 to 1995
WORLD ENERGY DEMAND									
(million barrels oil equivalent)									
OECD Countries (OECD)	29,702	30,118	30,389	30,875	31,400	31,808	32,381	+2,263	+ 7.5
Less Developed Countries (LDC's)	10,008	10,268	10,494	10,798	11,036	11,323	11,640	+1,372	+13.4
Centrally Planned Economies	19,027	19,274	19,505	19,876	20,273	20,678	21,091	+1,817	+ 9.4
Total	**58,737**	**59,660**	**60,388**	**61,549**	**62,709**	**63,809**	**65,112**	**+5,452**	**+9.1**
WORLD OIL DEMAND									
(thousand barrels/day)									
OECD Countries (OECD)	36,550	37,098	37,358	37,769	38,260	38,643	39,029	+1,931	+ 5.2
Less Developed Countries (LDC's)	14,470	14,803	15,099	15,476	15,801	16,164	16,568	+1,765	+11.9
Centrally Planned Economies	13,715	13,838	13,963	14,103	14,314	14,529	14,732	+ 894	+ 6.5
Total	**64,735**	**65,739**	**66,420**	**67,348**	**68,375**	**69,336**	**70,329**	**+4,590**	**+ 7.0**
PETROLEUM PRODUCT DEMAND									
OECD & LDC's									
(thousand barrels/day)									
Gasolines	16,351	16,631	16,770	16,961	17,159	17,339	17,529	+ 898	+ 5.4
Middle distillates	17,795	18,105	18,354	18,707	19,074	19,411	19,752	+1,647	+ 9.1
Fuel oil	8,157	8,300	8,347	8,395	8,474	8,552	8,631	+ 331	+ 4.0
Other products	8,717	8,865	8,986	9,182	9,354	9,505	9,685	+ 820	+ 9.2
Total	**51,020**	**51,901**	**52,457**	**53,245**	**54,061**	**54,807**	**55,597**	**+3,696**	**+ 7.1**
Crude oil price									
(Average world export price)									
($/barrel)	16.65	20.00	25.00	19.50	20.50	21.50	22.50	+ 2.50	+12.5

WORLDWIDE DEMAND KEYS TO THE FUTURE SCENARIO II

1. The dispute in the Middle East between Iraq and Kuwait will continue for 18 to 30 months. The embargo on oil exported from these two countries will continue over this period. Most of the production in these nations will be shut in over this period. This will result in substantially higher oil prices in 1991 and 1992.

2. Prices will move up in 1991, increasing 25% to $25/bbl due to the loss to the market of the substantial production and capacity in Iraq and Kuwait. Prices will continue to move up in 1992, increasing to $27.50/bbl. When the dispute is settled in 1993, prices will fall sharply to $19/bbl. The sharp drop in prices will be due to the return to worldwide excess production capacity. It is expected that in the latter years of the forecast period, prices will move up gradually, along with increased demand for petroleum products.

3. No recession is expected during the forecast period, but a slowdown in the economic growth rate is expected in 1991 and 1992 due to the higher oil prices. Europe 1992 is expected to give the worldwide economy a boost. The development of market economies in East Europe may also boost the worldwide economy later in the forecast period. Major problems with international debt, large budget deficits, unemployment, etc. will be contained. Population and environmental problems are expected to grow in importance.

4. After the dispute is resolved between the two OPEC countries, Iraq and Kuwait, the OPEC cartel will continue to have some influence over the worldwide oil industry. It is likely that the OPEC countries with large reserves will dictate oil policy. But OPEC will continue to have problems with controlling the overall production level, which will put some downward pressure on prices after the dispute is settled.

5. During the period of high energy prices there will be some incentive to invest in energy conservation. However, prices will not remain high long enough to result in a large investment. The relatively low oil and energy prices are expected to dampen the incentive for investing in energy conservation after prices fall. There will be continued improvement in energy consumption efficiency, but the rate of improvement will be slower.

6. The increased level of economic activity and relatively low oil prices will help stimulate demand for petroleum products. World demand for petroleum products is expected to increase over the forecast period.

7. Demand for distillate and other special products will lead the way in the growth in product demand. But lower prices will also stimulate demand for gasoline and heavy fuel oil. Demand for heavy fuel oil could move up even more if environmental concerns slow growth of nuclear energy or coal consumption.

THE OUTLOOK — WORLDWIDE DEMAND
SCENARIO — II

	1989	1990	1991	1992	1993	1994	1995	Change 1990 to 1995	% change 1990 to 1995
WORLD ENERGY DEMAND									
(million barrels oil equivalent)									
OECD Countries (OECD)	29,702	30,118	30,389	30,632	31,122	31,495	31,873	+1,755	+ 5.8
Less Developed Countries (LDC's)	10,008	10,268	10,494	10,704	11,014	11,322	11,639	+1,371	+13.4
Centrally Planned Economies	19,027	19,274	19,505	19,895	20,273	20,678	21,091	+1,817	+ 9.4
Total	**58,737**	**59,660**	**60,388**	**61,231**	**62,409**	**63,495**	**64,603**	**+4,943**	**+ 8.3**
WORLD OIL DEMAND									
(thousand barrels/day)									
OECD Countries (OECD)	36,550	37,098	37,358	37,657	38,109	38,490	38,875	+1,777	+ 4.8
Less Developed Countries (LDC's)	14,470	14,803	15,099	15,356	15,755	16,149	16,553	+1,750	+11.8
Centrally Planned Economies	13,715	13,838	13,963	14,158	14,300	14,515	14,719	+ 881	+ 6.4
Total	**64,735**	**65,739**	**66,420**	**67,171**	**68,164**	**69,154**	**70,147**	**+4,408**	**+ 6.7**
PETROLEUM PRODUCT DEMAND									
OECD & LDC's									
(thousand barrels/day)									
Gasolines	16,351	16,631	16,770	16,887	17,096	17,286	17,476	+ 845	+ 5.0
Middle distillates	17,795	18,105	18,354	18,625	19,004	19,351	19,692	+1,587	+ 8.8
Fuel oil	8,157	8,300	8,347	8,358	8,443	8,526	8,605	+ 305	+ 3.7
Other products	8,717	8,865	8,986	9,143	9,321	9,476	9,655	+ 790	+ 8.9
Total	**51,020**	**51,901**	**52,457**	**53,013**	**53,864**	**54,639**	**55,428**	**+3,527**	**+ 6.8**
Crude oil price									
(Average world export price)									
($/barrel)	16.65	20.00	25.00	27.50	19.00	20.50	22.00	+ 2.00	+10.0

WORLDWIDE DEMAND KEYS TO THE FUTURE SCENARIO III

1. The dispute in the Middle East between Iraq and Kuwait will be resolved within 6 months. The embargo on oil exported from these two countries will continue over this short period. Most of the production in these two nations will be shut in over this period. Oil prices in 1991 will fall after the dispute is resolved.

2. Prices will fall in 1991, dropping to an annual average of $18.00/bbl from $19.50/bbl in 1990. The drop in prices will be due to the return to worldwide excess production capacity. It is expected that throughout the years of the forecast period, prices will move up gradually, along with increased demand for petroleum products.

3. No recession is expected during the forecast period, but a slight slowdown in the economic growth rate is expected in 1991 partly due to the higher oil prices in 1990 and early 1991. Europe 1992 is expected to give the worldwide economy a boost. The development of market economies in East Europe may also boost the worldwide economy later in the forecast period. Major problems with international debt, large budget deficits, unemployment, etc. will be contained. Population and environmental problems are expected to grow in importance.

4. After the dispute is resolved between the two OPEC countries, Iraq and Kuwait, the OPEC cartel will continue to have some influence over the worldwide oil industry. It is likely that the OPEC countries with large reserves will dictate oil policy. But OPEC will continue to have problems with controlling the overall production level, which will put some downward pressure on prices after the dispute is settled.

5. During the short period of high energy prices there may be some incentive to invest in energy conservation. However, prices will not remain high long enough to result in a large investment. The relatively low oil and energy prices are expected to dampen the incentive for investing in energy conservation after prices fall. There will be continued improvement in energy consumption efficiency, but the rate of improvement will be slower.

6. The increased level of economic activity and relatively low oil prices will help stimulate demand for petroleum products. World demand for petroleum products is expected to increase over the forecast period.

7. Demand for distillate and special petroleum products will lead the way in the growth in product demand. Relatively low prices will also stimulate demand for gasoline and heavy fuel oil. Demand for heavy fuel oil could move up even more if environmental concerns slow growth of nuclear energy or coal consumption.

THE OUTLOOK — WORLDWIDE DEMAND
SCENARIO — III

	1989	1990	1991	1992	1993	1994	1995	Change 1990 to 1995	% change 1990 to 1995
WORLD ENERGY DEMAND									
(million barrels oil equivalent)									
OECD Countries (OECD)	29,702	30,266	30,811	31,427	31,867	32,313	32,733	+2,467	+ 8.2
Less Developed Countries (LDC's)	10,008	10,328	10,607	10,978	11,285	11,624	11,938	+1,610	+15.6
Centrally Planned Economies	19,027	19,369	19,698	20,112	20,434	20,802	21,197	+1,828	+ 9.4
Total	**58,737**	**59,963**	**61,116**	**62,517**	**63,586**	**64,739**	**65,868**	**+5,905**	**+ 9.8**
WORLD OIL DEMAND									
(thousand barrels/day)									
OECD Countries (OECD)	36,550	37,208	37,617	38,106	38,525	38,910	39,299	+2,091	+ 5.6
Less Developed Countries (LDC's)	14,470	14,933	15,336	15,873	16,270	16,709	17,110	+2,177	+14.6
Centrally Planned Economies	13,715	13,962	14,199	14,497	14,700	14,935	15,159	+1,197	+ 8.6
Total	**64,735**	**66,103**	**67,152**	**68,476**	**69,495**	**70,554**	**71,568**	**+5,465**	**+ 8.3**
PETROLEUM PRODUCT DEMAND									
OECD & LDC's									
(thousand barrels/day)									
Gasolines	16,351	16,690	16,929	17,195	17,392	17,596	17,785	+1,095	+ 6.6
Middle distillates	17,795	18,215	18,528	18,965	19,333	19,699	20,040	+1,825	+10.0
Fuel oil	8,157	8,316	8,426	8,511	8,589	8,679	8,757	+ 441	+ 5.3
Other products	8,717	8,920	9,070	9,308	9,481	9,645	9,827	+ 907	+10.2
Total	**51,020**	**52,141**	**52,953**	**53,979**	**54,795**	**55,619**	**56,409**	**+4,268**	**+ 8.2**
Crude oil price									
(Average world export price)									
($/barrel)	16.65	19.50	18.00	20.00	21.00	22.00	23.00	+ 3.50	+17.9

WORLDWIDE OUTLOOK—SUPPLY

The Iraqi invasion of Kuwait in early August 1990 substantially changed the world supply picture. At the time of the invasion these two countries were producing 4.7 million b/d and had estimared production capacity of 5.7 million b/d.

Following the invasion on embargo was placed on the 4.2 million b/d of crude oil exports form these two countries. The loss to the world oil market of this substantial volume immediately tightened the

crude oil market and drove up crude prices.

For a substantial number of years there has been excess production capacity in the world, which has had a tendency to put downward pressure on prices. Most of that excess capacity was in the OPEC countries. With the loss of the production capacity of Kuwait and Iraq, a substantial portion of the excess capacity has evaporated. There is even some danger of a temporary supply shortage when demand moves up in the winter heating season.

If this production is lost for an extended period of time, it couid substantially alter the long term outlook for the worldwide oil industry. This alteration would be exaggerated if the other OPEC countries with excess capacity do not boost production to make up for the shortage.

Prior to this upheaval, control over the supply side of the world petroleum market was slipping more and more into the hands of OPEC. Total non-OPEC production appears close to peaking. An even if there is potential for some growth in non-OPEC production, it does not appear that it will keep pace with the growth in demand. Therefore OPEC would increase market share along with an increase in overall demand for crude oil.

The recent events in the Middle East will not substantially alter this pattern if the other OPEC countries expand their production and capacity to make up for the temporary loss. If capacity is increased, OPEC will be in an even better position to stimulate demand for oil and meet expanded demand requirements.

For the foreseeable future the level of production emanating from the OPEC group of countries will be a major factor in determining the level of crude oil prices, the level of investment and the level and type of activity throughout the worldwide oil industry.

The OPEC countries should have learned a profitable lesson in 1986 and 1988 when excess production drove prices down to an unacceptably low level. Following the price crash and loss of revenue, OPEC should know that some level of cooperation and restraint is essential to optimize income from the market.

But individual country inter nal political or economic considerations within OPEC often outweigh the need to cooperate. This dispute between Iraq and Kuwait emphasizes that point. Political considerations often far outweigh economic considerations and these political moves are hard to predict.

What has not changed because of the upheaval in the Middle East is the fact that there exists substantial oil reserves and oil production capacity in many of the OPEC countries. When economics return to control the market place, this will become significant.

For the countries with large reserves, production volumes sufficient to create relatively low oil prices are in their long-run best interests. These countries prefer a price that will stimulate long-term steady growth in oil demand.

REVIEW

PRODUCTION. Economic activity worldwide expanded substantially and with little interruption throughout the 1950s, the 1960s and into the 1970s. A substantial proportion of the economic activity and growth was fueled by crude oil. Worldwide production of crude oil expanded steadily throughout this period to meet the ever-increasing demand. New field development and capacity additions were sustained at a pace close to that of the demand for oil, which in turn tracked the economic growth rate.

But two major price increases, the first in 1973–74 and the second in 1979–81, put an end to this steady climb in crude production. With worldwide economic growth fueled by oil consumption, the first price increase only slowed consumption. But it did give rise to some serious thought about investment in energy conservation.

WORLDWIDE OIL RESERVES

	Jan. 1 (1,000 bbl)													Change	% change
	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1990-1980	1990/1980
Australia	2,000,000	2,100,000	2,130,000	2,360,000	1,709,000	1,622,077	1,586,000	1,430,900	1,449,000	1,712,800	1,691,960	1,673,089	1,676,500	−453,500	−21.3
Brunei	1,550,000	1,480,000	1,800,000	1,710,000	1,630,000	1,240,000	1,390,000	1,400,000	1,480,000	1,420,900	1,420,000	1,400,000	1,375,000	−425,000	−23.6
India	3,000,000	2,900,000	2,600,000	1,710,000	2,672,000	3,416,400	3,485,000	3,500,000	3,736,000	4,202,800	4,250,000	6,354,200	7,516,400	+4,916,400	+189.1
Indonesia	10,000,000	10,200,000	9,600,000	9,500,000	9,800,000	9,550,000	9,100,000	8,650,000	8,500,000	8,300,000	8,400,000	8,250,000	8,200,000	−1,400,000	−14.6
Malaysia	2,500,000	2,800,000	2,800,000	3,000,000	2,800,000	3,325,000	3,000,000	3,000,000	3,100,000	2,820,500	2,900,000	2,922,000	2,950,000	+150,000	+5.4
Others	699,270	527,200	425,200	480,500	541,800	602,600	408,400	549,000	591,300	566,500	691,690	768,088	827,451	+402,251	+94.6
Total Asia-Pacific	**19,479,270**	**20,007,200**	**19,355,200**	**19,630,500**	**19,150,800**	**19,756,077**	**18,969,400**	**18,529,900**	**18,856,300**	**19,023,500**	**19,353,650**	**21,367,377**	**22,545,351**	**+3,190,151**	**+16.5**
Norway	6,000,000	5,900,000	5,750,000	5,500,000	7,620,000	6,800,000	7,660,000	8,300,000	10,900,000	10,500,000	14,800,000	10,435,000	11,546,204	+5,796,204	+100.8
United Kingdom	19,000,000	16,000,000	15,400,000	14,800,000	14,800,000	13,900,000	13,150,000	13,590,000	13,000,000	9,000,000	5,200,000	5,175,000	4,255,620	−11,144,380	−72.4
Others	1,862,500	2,066,000	2,626,400	2,785,000	2,214,500	2,223,680	2,209,480	2,535,500	2,512,600	2,438,050	2,447,820	2,946,575	3,020,273	+393,873	+15.0
Total Western Europe	**26,862,500**	**23,966,000**	**23,776,400**	**23,085,000**	**24,634,500**	**22,923,680**	**23,019,480**	**24,425,500**	**26,412,600**	**21,938,050**	**22,447,820**	**18,556,575**	**18,822,097**	**−4,954,303**	**−20.8**
Abu Dhabi	31,000,000	30,000,000	28,000,000	29,000,000	30,600,000	30,510,000	30,400,000	30,500,000	31,000,000	31,000,000	92,205,000	92,205,000	92,205,000	+64,205,000	+229.3
Divided Zone	6,200,000	6,480,000	6,260,000	6,060,000	6,500,000	5,840,000	5,695,000	5,420,000	5,380,000	5,212,100	5,210,000	5,120,000	5,200,000	−1,060,000	−16.9
Dubai	1,400,000	1,300,000	1,400,000	1,400,000	1,270,000	1,440,000	1,440,000	1,440,000	1,400,000	1,350,000	4,000,000	4,000,000	4,000,000	+2,600,000	+185.7
Iran	62,000,000	59,000,000	58,000,000	57,500,000	57,000,000	55,308,000	51,000,000	48,500,000	47,876,000	48,800,000	92,850,000	92,850,000	92,860,000	+34,860,000	+60.1
Iraq	34,500,000	32,100,000	31,000,000	30,000,000	29,700,000	41,000,000	43,000,000	44,500,000	44,110,000	47,100,000	100,000,000	100,000,000	100,000,000	+69,000,000	+222.6
Kuwait	67,000,000	66,200,000	65,400,000	64,900,000	64,480,000	64,230,000	63,900,000	90,000,000	89,774,000	91,916,000	91,920,000	91,920,000	94,525,000	+29,125,000	+44.5
Oman	5,650,000	2,500,000	2,400,000	2,340,000	2,570,000	2,730,000	2,790,000	3,500,000	4,000,000	4,032,000	4,012,000	4,071,160	4,250,000	+1,850,000	+77.1
Qatar	5,600,000	4,000,000	3,760,000	3,585,000	3,434,000	3,425,000	3,330,000	3,350,000	3,300,000	3,154,000	3,150,000	3,150,000	4,500,000	+740,000	+19.7
Saudi Arabia	150,000,000	165,700,000	163,350,000	165,000,000	164,600,000	162,400,000	169,000,000	169,000,000	168,800,000	166,573,900	166,980,000	169,970,000	254,959,000	+91,609,000	+56.1
Syria	2,150,000	2,080,000	2,000,000	1,940,000	1,890,000	1,521,000	1,495,000	1,450,000	1,440,000	1,400,000	1,750,000	1,730,000	1,730,000	−270,000	−13.5
Others	666,000	636,000	377,300	346,000	795,950	881,893	1,055,800	720,750	945,710	1,340,700	2,603,250	6,412,619	6,108,191	+5,640,891	+1,495.1
Total Middle East	**366,166,000**	**369,996,000**	**361,947,300**	**362,071,000**	**362,839,950**	**369,285,893**	**370,100,800**	**398,380,750**	**398,025,710**	**401,878,700**	**564,680,250**	**571,518,779**	**660,247,191**	**+298,299,891**	**+82.4**
Algeria	6,600,000	6,300,000	8,440,000	8,200,000	8,080,000	9,440,000	9,220,000	9,000,000	8,820,000	8,800,000	8,500,000	8,400,000	9,200,000	+760,000	+9.0
Angola-Cabinda	1,160,000	1,115,000	1,200,000	1,200,000	1,450,000	1,635,000	1,700,000	1,800,000	2,000,000	1,149,400	1,149,000	2,024,000	2,024,000	+824,000	+68.7
Congo Republic	360,000	315,000	400,000	660,000	1,300,000	1,550,000	400,000	480,000	650,000	720,000	720,000	710,000	830,000	+430,000	+107.5
Egypt	2,450,000	3,200,000	3,100,000	2,900,000	2,930,000	3,325,000	3,450,000	3,200,000	3,850,000	3,600,000	4,300,000	4,300,000	4,500,000	+1,400,000	+45.2
Libya	25,000,000	24,300,000	23,500,000	23,000,000	22,600,000	21,500,000	21,270,000	21,100,000	21,300,000	21,300,000	21,000,000	22,000,000	22,800,000	−700,000	−3.0
Nigeria	18,700,000	18,200,000	17,400,000	16,700,000	16,500,000	16,750,000	16,550,000	16,650,000	16,600,000	16,000,000	15,980,000	16,000,000	16,000,000	−1,400,000	−8.0
Tunisia	2,670,000	2,300,000	2,250,000	1,652,000	1,690,000	1,860,000	1,820,000	1,514,000	1,800,000	1,800,000	1,800,000	1,790,000	1,750,000	−500,000	−22.2
Others	2,260,150	2,162,125	782,100	836,375	1,621,630	1,761,690	2,497,020	1,796,550	1,714,050	1,824,650	1,800,700	1,739,770	1,732,620	+950,520	+121.5
Total Africa	**59,200,150**	**57,892,125**	**57,072,100**	**55,148,375**	**56,171,630**	**57,821,690**	**56,907,020**	**55,540,550**	**56,734,050**	**55,194,050**	**55,249,700**	**56,953,770**	**58,836,620**	**+1,764,520**	**+3.1**
Argentina	2,503,000	2,400,000	2,400,000	2,457,000	2,650,000	2,590,000	2,428,700	2,266,000	2,300,000	2,270,000	2,270,000	2,268,000	2,279,900	−120,000	−5.0
Brazil	880,000	1,200,000	1,220,000	1,300,000	1,325,060	1,750,000	1,800,000	1,976,000	2,070,000	2,250,000	2,340,000	2,550,000	2,816,000	+1,596,000	+130.8
Ecuador	1,640,000	1,170,000	1,100,000	1,100,000	850,000	1,400,000	1,675,000	1,400,000	1,650,000	1,672,300	1,615,000	1,350,000	1,514,000	−414,000	−37.6
Mexico	14,000,000	16,000,000	31,250,000	44,000,000	56,990,000	48,300,000	48,000,000	48,600,000	49,300,000	54,653,000	48,610,000	54,110,000	56,365,000	+25,115,000	+80.4
Venezuela	18,200,000	18,000,000	17,870,000	17,950,000	20,300,000	21,500,000	24,850,000	25,845,000	25,591,000	25,000,000	56,300,000	58,083,900	58,504,000	+40,634,000	+227.4
United States	29,500,000	28,500,000	26,500,000	26,400,000	29,785,000	29,785,000	27,300,000	27,300,000	28,000,000	24,560,000	25,270,000	26,500,000	25,860,000	−640,000	−2.4
Canada	6,000,000	6,000,000	6,800,000	6,400,000	7,300,000	7,020,000	6,730,000	7,075,000	6,500,000	6,850,000	6,825,000	6,785,514	6,133,495	−666,505	−9.8
Others	3,147,000	2,476,500	2,632,500	2,682,837	2,867,210	2,942,066	2,922,200	3,228,700	3,331,400	2,870,000	3,186,980	3,588,836	3,547,969	+915,469	+34.8
Total Western Hemisphere	**75,870,000**	**75,746,500**	**89,772,500**	**102,289,837**	**122,067,270**	**115,287,066**	**115,705,900**	**117,690,700**	**118,742,400**	**120,125,300**	**146,416,980**	**155,236,250**	**157,020,364**	**+67,247,864**	**+74.9**
Total Non-Communist	**547,847,920**	**547,607,825**	**551,923,500**	**562,224,712**	**584,864,150**	**585,074,406**	**584,702,600**	**614,567,400**	**618,771,060**	**618,199,600**	**808,148,400**	**823,642,751**	**917,471,623**	**+365,548,123**	**+66.2**
China	20,000,000	20,000,000	20,000,000	20,500,000	19,895,000	19,485,000	19,100,000	19,100,000	18,420,000	18,400,000	18,400,000	23,550,000	24,000,000	+4,000,000	+20.0
U.S.S.R.	75,000,000	71,000,000	67,000,000	63,000,000	63,000,000	63,000,000	63,000,000	63,000,000	61,000,000	59,000,000	59,000,000	58,500,000	58,400,000	−8,600,000	−12.8
Others	3,000,000	3,000,000	3,000,000	2,800,000	2,950,000	2,630,000	2,500,000	2,000,000	1,950,000	1,850,000	1,800,000	1,750,000	1,700,000	−1,300,000	−43.3
Total Communist	**98,000,000**	**94,000,000**	**90,000,000**	**86,300,000**	**85,845,000**	**85,115,000**	**84,600,000**	**84,100,000**	**81,370,000**	**79,250,000**	**79,200,000**	**83,800,000**	**84,100,000**	**−5,900,000**	**−6.6**
Total World	**645,847,920**	**641,607,825**	**641,623,500**	**648,524,712**	**670,709,150**	**670,189,406**	**669,302,600**	**698,667,400**	**700,141,060**	**697,449,600**	**887,348,400**	**907,442,751**	**1,001,571,623**	**+359,648,123**	**+56.0**
Total OPEC	**440,185,000**	**445,186,000**	**435,831,300**	**434,580,000**	**436,709,000**	**436,858,000**	**448,420,000**	**476,415,000**	**475,[illegible]000**	**477,523,300**	**670,655,000**	**676,008,900**	**767,100,000**	**+331,268,700**	**+76.0**
OPEC as % of world	68.2%	69.4%	68.0%	67.1%	65.2%	65.2%	67.0%	68.2%	67.9%	68.5%	75.6%	74.5%	76.6%	—	—

Source: Oil & Gas Journal

The second, larger, price increase stopped the growth in oil consumption and production in its tracks. The second major price increase occurred in the 1979–81 period. It was the major reason for the subsequent decrease in consumption and production of oil. Not only were steps taken to conserve energy and to reduce energy costs, but these adjustments led to a slowdown in economic activity. And this contributed further to the drop in demand for oil.

Total world hydrocarbon liquids production (crude oil, condensate and natural gas liquids) peaked in 1979 at 65.78 million bld. Production in the non-communist world also peaked in 1979 at 51.28 million bld. The increased cost of oil forced conservation, and world production fell for four consecutive years, 1979–83, dropping to 56.69 million b/d in 1983. This was a drop in production of 9.09 million b/d, or 13.8%.

Non-communist production, which is more sensitive to market forces, fell 9.74 million b/d (19%) to 41.54 million b/d. Communist area production actually continued to rise over this period, increasing from 14.495 million b/d in 1979 to 15.145 million b/d in 1983.

The drop in world crude production mirrored the drop in demand for petroleum products. The latter was a direct result of the sharp increase in the price of oil products, resulting from the OPEC crude price increases. In addition, there was a rapid shift to other energy sources for fueling economic growth. Although the costs of other energy forms were also on the rise, they were not increasing as rapidly as the cost of oil. Oil led the way and became the highest-cost energy form for many economic activities.

With declining demand for crude oil products and therefore for crude production, prices began to slide in the last half of 1981. With weak demand relative to supply, prices slid downward gradually throughout the 1981–85 period.

The downward pressure on prices from the excess capacity and the excess production intensified in 1986 and prices plummeted sharply. Tighter supply due to some OPEC production discipline led to a slight rebound in 1987. Excess OPEC production put downward pressure on prices again in 1988. Prices weakened and fell, although they did not fall as sharply or as far as in 1986. The following year, 1989, was a repeat of 1987 with a rebound in prices followed by relative price stability. A sharp drop in U.S. and U.K. production, coupled with some OPEC production discipline, helped to stabilize the market. Prices were weak in 1990 but did not drop as sharply as in 1986 and 1988. Prices were beginning to move up just prior to the invasion.

The lower prices slowed conservation efforts and slightly stimulated demand over the 1981–85 period. There was also a slight rebound in production in 1984, both total world and non-communist. Non-communist production increased 1.33 million b/d, 3.2%, to 42.87 million b/d. Total world output increased 1.41 million b/d, up 2.5% to 58.1 million b/d. Lower crude oil prices and increased economic growth and increased oil product demand were the major reasons for this increase in production. The year following, in 1985, production slipped slightly. Total non-communist production dropped to 42.58 million b/d. Total world output fell to 57.71 million b/d.

However, this was reversed again when the slump in prices in 1986 kicked off a surge in demand for oil. Non-communist output jumped up 2.2 million b/d to 44.7 million b/d, total world output was up 2.7 million b/d at 60.4 million b/d, the highest level since 1980.

Due to higher prices output slipped slightly in 1987, falling 225,000 b/d. The drop was all in the non-communist output, which dipped 460,000 b/d. Lower crude prices in 1988 again reversed the direction and output moved up over 2 million b/d. Non-communist output jumped up to 46.4 million b/d, and total world production moved up to 62.35 million b/d. Prices were relatively stable throughout most of 1989, but low enough to stimulate demand Non-communist production moved up another 1.4 million b/d on the

WORLDWIDE OIL PRODUCTION*

Country/Area	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	% change 89/79
						(1,000 b/d)						
North America												
U.S.	10,135	10,170	10,180	10,200	10,245	10,505	10,545	10,230	9,945	9,765	9,175	−9.5
Canada	1,770	1,725	1,545	1,485	1,515	1,645	1,815	1,840	1,815	1,800	1,725	−2.5
TOTAL NORTH AMERICA	**11,905**	**11,895**	**11,725**	**11,685**	**11,760**	**12,150**	**12,360**	**12,070**	**11,760**	**11,565**	**10,900**	**−8.4**
Latin America												
Argentina	470	490	490	490	475	465	460	430	430	450	450	−4.3
Brazil	170	195	220	275	365	460	585	595	620	645	640	276.5
Colombia	150	125	135	145	155	170	175	300	385	380	400	166.7
Ecuador	215	205	210	200	240	255	275	280	180	305	285	32.6
Mexico	1,630	2,155	2,585	3,005	2,950	3,015	3,015	2,750	2,875	2,855	2,875	76.4
Trinidad	215	210	200	175	165	170	175	165	165	150	160	−25.6
Venezuela	2,425	2,235	2,180	1,965	1,875	1,875	1,730	1,845	1,775	1,920	1,980	−18.4
Others	260	280	280	305	270	285	285	270	250	225	200	−23.1
TOTAL LATIN AMERICA	**5,535**	**5,895**	**6,300**	**6,560**	**6,495**	**6,695**	**6,700**	**6,635**	**6,680**	**6,930**	**6,990**	**26.3**
Western Europe												
Austria	35	30	25	25	25	25	25	20	20	25	25	−28.6
Denmark	10	5	15	35	45	45	60	75	95	95	115	1,050.0
France	25	30	35	50	50	60	70	75	75	75	75	200.0
Italy	30	35	25	30	40	40	45	50	70	85	80	166.7
Norway	385	525	505	530	660	755	835	910	1,005	1,155	1,530	297.4
Turkey	55	45	45	45	45	40	40	45	50	50	50	−9.1
United Kingdom	1,600	1,650	1,835	2,125	2,360	2,580	2,655	2,665	2,555	2,365	1,905.0	19.1
West Germany	95	90	90	85	80	80	80	80	75	80	75	−21.1
Others	60	65	60	95	145	140	150	155	150	135	115.0	91.7
TOTAL WESTERN EUROPE	**2,295**	**2,475**	**2,635**	**3,020**	**3,450**	**3,765**	**3,960**	**4,075**	**4,095**	**4,065**	**3,970**	**73.0**
U.S.S.R. and Eastern Europe												
U.S.S.R.	11,870	12,215	12,370	12,430	12,520	12,450	12,150	12,560	12,775	12,760	12,475	5.1
Eastern Europe	495	470	440	495	475	470	445	455	430	425	410	−17.2
TOTAL USSR & E. EUROPE	**12,365**	**12,685**	**12,810**	**12,925**	**12,995**	**12,920**	**12,595**	**13,015**	**13,205**	**13,185**	**12,885**	**4.2**
Middle East												
Abu Dhabi	1,465	1,345	1,135	885	830	825	890	1,090	1,200	1,280	1,600	9.2
Dubai & N. Emirates	370	360	370	365	350	395	460	465	495	495	470	27.0
Iran	3,175	1,480	1,325	2,410	2,465	2,195	2,215	1,905	2,310	2,265	2,865	−9.8
Iraq	3,475	2,645	895	1,010	1,105	1,225	1,440	1,745	2,090	2,600	2,825	−18.7
Kuwait	2,270	1,430	965	705	900	985	920	1,250	1,075	1,340	1,600	−29.5
Neutral Zone	570	545	375	315	310	405	340	345	390	320	400	−29.8
Oman	295	285	325	325	390	420	505	560	580	595	590	100.0
Qatar	510	460	425	340	310	425	340	355	340	355	395	−22.5
Saudi Arabia	9,555	9,990	9,985	6,695	5,225	4,760	3,565	5,150	4,360	5,255	5,260	−45.0
Others	225	215	215	220	225	220	220	240	285	495	585	160.0
TOTAL MIDDLE EAST	**21,910**	**18,755**	**16,015**	**13,270**	**12,110**	**11,855**	**10,895**	**13,105**	**13,125**	**15,000**	**16,590**	**−24.3**
Africa												
Algeria	1,255	1,120	1,035	1,045	980	1,075	1,095	1,125	1,135	1,090	1,170	−6.8
Angola	150	150	140	120	160	185	230	280	350	450	455	203.3
Egypt	525	590	690	705	725	860	905	835	915	880	890	69.5
Gabon	205	175	150	155	155	150	155	160	155	175	220	7.3
Libya	2,090	1,830	1,220	1,135	1,110	1,105	1,105	1,045	1,000	1,055	1,145	−45.2
Nigeria	2,300	2,055	1,440	1,285	1,235	1,385	1,475	1,465	1,290	1,365	1,605	−30.2
Others	225	260	305	340	380	440	450	465	445	465	460	104.4
TOTAL AFRICA	**6,750**	**6,180**	**4,980**	**4,785**	**4,745**	**5,200**	**5,415**	**5,375**	**5,290**	**5,480**	**5,945**	**−11.9**
Asia and Australasia												
Brunei	240	235	175	165	175	160	150	165	140	145	145	−39.6
China	2,130	2,125	2,035	2,050	2,135	2,300	2,515	2,630	2,675	2,750	2,790	31.0
India	260	190	300	400	510	565	605	625	615	645	690	165.4
Indonesia	1,590	1,575	1,680	1,415	1,345	1,410	1,335	1,400	1,320	1,325	1,395	−12.3
Japan	10	10	10	10	10	10	10	15	10	10	10	0.0
Malaysia	285	275	250	295	420	440	435	540	505	545	575	101.8
Other Asia	50	60	50	55	70	85	100	115	110	105	100	100.0
Australasia	455	400	410	420	470	550	635	610	620	600	575	26.4
TOTAL ASIA & AUSTRALASIA	**5,020**	**4,870**	**4,910**	**4,810**	**5,135**	**5,520**	**5,785**	**6,100**	**5,995**	**6,125**	**6,280**	**25.1**
TOTAL WORLD	**65,780**	**62,755**	**59,375**	**57,055**	**56,690**	**58,105**	**57,710**	**60,375**	**60,150**	**62,350**	**63,560**	**−3.4**
OPEC	**31,470**	**27,450**	**23,390**	**19,925**	**18,435**	**18,470**	**17,340**	**19,625**	**19,115**	**21,145**	**23,215**	**−26.2**

*Includes natural gas liquids

Source: British Petroleum

strength of the strong economic growth and product demand. Communist production dipped due to internal production problems in the U.S.S.R.

The level of output or demand for crude oil is quite obviously very sensitive to the price of crude oil and is being dampened or stimulated by the volatile price movements.

OPEC PRODUCTION AND CAPACITY. The initial drop in prices in 1981–83 was mainly due to the development of a massive excess crude oil production capacity worldwide. The vast majority of the excess capacity developed in the OPEC countries. Both the increased output in non-OPEC countries and the drop in product demand worldwide contributed to the development of an excess capacity problem in the oil industry. In fact, the worldwide production capacity situation is the real key to understanding the world oil supply situation and crude oil price developments.

Throughout the 1950s, 1960s and into the 1970s, as more and more oil was required to fuel worldwide economic growth, production capacity was expanded to meet the demand. Production facilities were installed to allow a buffer for maintenance and other non-routine contingencies. Generally, development plans called for output to average about 92% of installed capacity. This allows for some excess capacity for maintenance downtime and other contingencies.

The international oil companies, as a rule, obtained concessions and developed the lower-cost areas first. These were mainly the prolific fields of the now OPEC countries. Capacity seldom exceeded demand by a large amount because the rate of installation of new capacity was regulated to meet demand growth.

As demand for oil increased throughout the 1960s and into the 1970s, it was increased production from the OPEC countries that filled the need. By 1976, OPEC output represented 51.8% of total worldwide output, and 65.6% of non-communist world production.

OPEC production actually peaked in 1977 at 31.68 million b/d, 50.6% of worldwide production, and 64.5% of non-communist production. OPEC output remained above 30 million b/d in 1978 and 1979, with 1979 at 31.47 million b/d. That was 47.8% of total world demand and 61.4% of non-communist demand for that year.

By 1979, OPEC was beginning to lose a part of its market share because the substantial increase in prices stimulated the development of crude production in non-OPEC countries, and non-OPEC output was beginning to supply a greater proportion of demand.

In the late 1960s and early 1970s, as worldwide demand was on the rise, the OPEC countries gained control of their own oil resources by taking control from the international oil companies. And they subsequently changed the approach to supplying worldwide oil demand that had been followed by the international oil companies.

The international companies had been efficient at exploration and production. The price was kept low by continuous development of additional oil resources in the face of rising demand.

Oil resources were abundant in many of the OPEC countries, and the international oil companies managed to increase capacity to keep step with demand. This also kept prices low. And the low prices encouraged increased consumption.

The OPEC countries had contended for some time that their oil resources were worth more than the revenues received. When OPEC took control, they changed course and raised prices. They took advantage of the worldwide dependence on oil and the worldwide economic expansion that was being fueled by oil. They chose to test the demand response to higher prices (elasticity of demand), and raised prices sharply in 1973–74. Even in the face of a sharp price hike, demand continued to rise. So they boosted prices again in 1979–81.

These price hikes had a dramatic impact on the production capacity situation worldwide,

WORLDWIDE NATURAL GAS PRODUCTION

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	% change 89/79
	(Billion cu ft)											
North America												
U.S.	19,674	19,510	19,306	17,891	16,201	17,573	16,570	16,143	16,707	17,134	17,185	−12.7
Canada	2,944	2,709	2,642	2,607	2,454	2,524	2,701	2,521	2,771	3,203	3,457	17.4
TOTAL NORTH AMERICA	**22,618**	**22,219**	**21,948**	**20,498**	**18,655**	**20,097**	**19,271**	**18,664**	**19,478**	**20,337**	**20,642**	**−8.7**
Latin America												
Argentina	255	278	294	341	365	474	498	662	659	757	847	232.2
Bolivia	74	86	90	94	90	86	86	90	94	98	102	37.8
Colombia	94	98	102	98	133	149	145	145	145	172	169	79.8
Mexico	725	851	913	1,007	1,000	976	992	874	929	921	937	29.2
Trinidad	114	86	86	86	106	122	114	125	137	157	153	34.2
Venezuela	576	588	588	600	553	612	612	674	655	655	694	20.5
Others	141	125	118	149	172	200	223	227	231	235	220	56.0
TOTAL LATIN AMERICA	**1,979**	**2,112**	**2,191**	**2,375**	**2,419**	**2,619**	**2,670**	**2,797**	**2,850**	**2,995**	**3,122**	**57.8**
Western Europe												
France	282	274	259	243	216	208	176	137	125	102	102	−63.8
Italy	474	404	455	498	435	459	486	564	576	584	600	26.6
Netherlands	2,775	2,701	2,650	2,285	2,395	2,411	2,524	2,203	2,199	1,956	2,074	−25.3
Norway	760	925	921	898	898	972	894	953	1,047	1,051	1,129	48.6
United Kingdom	1,341	1,254	1,250	1,196	1,200	1,305	1,454	1,529	1,599	1,541	1,486	10.8
West Germany	604	553	564	494	514	537	478	537	592	553	533	−11.8
Others	94	90	86	106	110	129	161	180	176	196	223	137.2
TOTAL WESTERN EUROPE	**6,330**	**6,201**	**6,185**	**5,720**	**5,768**	**6,021**	**6,173**	**6,103**	**6,314**	**5,983**	**6,147**	**−2.9**
U.S.S.R. and Eastern Europe												
U.S.S.R.	13,183	14,104	15,276	16,241	17,377	19,032	20,843	21,725	22,983	24,292	25,264	91.6
Eastern Europe	1,544	1,517	1,592	1,599	1,650	1,752	1,760	1,791	1,740	1,576	1,505	−2.5
TOTAL U.S.S.R. AND EASTERN EUROPE	**14,727**	**15,621**	**16,868**	**17,840**	**19,027**	**20,784**	**22,603**	**23,516**	**24,723**	**25,868**	**26,769**	**81.8**
Middle East												
Abu Dhabi	153	192	255	235	239	329	392	455	447	455	466	204.6
Iran	706	294	255	255	388	478	514	537	564	706	764	8.2
Kuwait	306	243	188	145	169	153	149	204	169	227	294	− 3.9
Saudi Arabia	259	341	576	439	427	643	662	902	945	1,027	1,066	311.6
Others	380	388	329	365	325	416	470	502	627	800	847	122.9
TOTAL MIDDLE EAST	**1,804**	**1,458**	**1,603**	**1,439**	**1,548**	**2,019**	**2,187**	**2,600**	**2,752**	**3,215**	**3,437**	**90.5**
AFRICA												
Algeria	917	757	866	941	1,258	1,192	1,211	1,219	1,396	1,470	1,576	71.9
Libya	239	184	141	118	129	161	184	223	235	200	180	−24.7
Nigeria	47	39	63	43	51	59	51	43	129	133	141	200.0
Others	63	71	71	110	125	165	223	235	255	274	314	398.4
TOTAL AFRICA	**1,266**	**1,051**	**1,141**	**1,212**	**1,563**	**1,577**	**1,669**	**1,720**	**2,015**	**2,077**	**2,211**	**74.6**
Asia and Australasia												
China	490	478	455	392	423	427	451	463	490	494	506	3.3
Japan	86	78	74	71	74	74	78	74	78	74	71	−17.4
Indonesia	557	655	678	694	780	1,027	1,070	1,247	1,290	1,341	1,403	151.9
Other East Asia	314	318	329	372	447	678	839	949	1,058	1,141	1,200	282.2
Pakistan	200	243	239	310	337	357	365	388	419	443	439	119.5
Other South Asia	196	220	259	361	404	494	506	529	584	651	706	260.2
Australasia*	384	427	466	494	533	545	600	682	678	706	796	107.3
TOTAL ASIA AND AUSTRALASIA	**2,227**	**2,419**	**2,500**	**2,694**	**2,998**	**3,602**	**3,909**	**4,332**	**4,597**	**4,850**	**5,121**	**130.0**
TOTAL WORLD	**50,951**	**51,081**	**52,436**	**51,778**	**51,978**	**56,719**	**58,482**	**59,732**	**62,729**	**65,325**	**67,449**	**32.4**

*Includes Australia and New Zealand

Source: British Petroleum

but particularly in the OPEC countries.

Through the 1960s and up until 1973, excess capacity in the worldwide oil industry was 7–8%. Excess capacity was about 7% of total capacity and 8% of production. After the initial price hike, excess capacity began to increase, moving up to 10–12% in 1974 and as high as 19–25% in 1975. This was 19% of available capacity and 25% of actual production. The Iranian revolution in 1978–79 took some Iranian

PRICE–ARABIAN LIGHT CRUDE

Year	Average government selling price	Average spot market price	Difference
	— (U.S. dollars per barrel) —		
1975	10.46	10.70	+ 0.24
1976	11.51	11.63	+ 0.12
1977	12.09	12.43	+ 0.34
1978	12.70	13.00	+ 0.30
1979	13.34	29.89	+16.55
1980	26.00	35.69	+ 9.69
1981	32.00	34.30	+ 2.30
1982	34.00	31.76	− 2.24
1983	34.00	28.80	− 5.20
1984	29.00	27.80	− 1.20
1985	29.00	26.60	− 2.40
1986	28.00	23.00	− 5.00
1987	17.53	17.29	− 0.24
1988	13.43	13.28	− 0.15
1989	16.35	16.30	− 0.05

Source: Energy Information Administration

WORLD CRUDE OIL PRICES

Official Sales and Term Contracts
(Dollars per barrel)
(1 January)

Year	Total World	Total OPEC	Total Non-OPEC	Difference Non-OPEC-OPEC
1979	13.08	13.03	13.44	+ 0.41
1980	28.84	28.30	31.94	+ 3.64
1981	35.49	34.82	38.54	+ 3.72
1982	34.18	34.13	34.35	+ 0.22
1983	33.00	33.54	31.72	− 1.82
1984	28.61	28.59	28.65	+ 0.06
1985	28.33	28.43	28.16	− 0.27
1986	27.10	27.81	26.14	− 1.67
1987	16.24	16.10	16.44	+ 0.34
1988	16.57	16.77	16.21	− 0.56
1989	13.58	13.36	14.06	+ 0.70
1990	18.91	18.72	19.29	+ 0.57
CHANGE 1981 to 1989				
Actual	− 16.58	− 16.10	− 19.25	
Percentage	− 46.7 %	− 46.2 %	− 49.9 %	
CHANGE 1979 to 1981				
Actual	+ 22.41	+ 21.79	+ 25.10	
Percentage	+171.3 %	+167.2 %	+186.8 %	

Source: Energy Information Administration

THE STRAIT OF HORMUZ—1989

Country	Crude oil production (1,000 b/d)
Iran	2,947
Kuwait	1,593
Bahrain	43
Saudi Arabia	4,995
Qatar	387
United Arab Emirates	1,866
Total	**11,831**
Free world production	44,381
% of free world production	26.7
Exports via Strait of Hormuz	
Crude	7,900
Products	1,400
Total	**9,300**
Free world crude imports	21,050
% of free world crude imports	37.5%
Free world crude & product imports	28,980
% of free world crude & product imports	32.1%

Source: Author's estimates

capacity out of service and helped reduce excess capacity to the 9–10% level. This allowed OPEC to push through the massive 1979–81 price increase.

However, following 1979, the combination of declining demand and rising non-OPEC production resulted in the development of massive excess capacity. Most OPEC capacity had been put in place by 1977, but non-OPEC production was stimulated by the increase in prices, and new capacity was added continuously. Only the Iranian revolution and the Iran-Iraq war kept the excess capacity situation somewhat in check. But by 1983 excess capacity was 15.6 million b/d, which was 29% of total capacity and 41% of total production/demand. This started to put substantial downward pressure on prices.

Excess capacity dropped only marginally in 1984, to 15.3 million b/d. This was still 28% of total available non-communist capacity and 39% of total production. In 1985, excess capacity moved up again to 15.6 million b/d. This represented 29% of total non-communist oil production capacity, and about 40% of total oil production. In 1986, the excess capacity fell slightly to 14 million b/d. This was 26% of total capacity and 35% of total production. In 1987, there was little change in these numbers. And the excess capacity continued to exert downward pressure on prices.

These capacity numbers exclude some capacity in Iran and Iraq that was damaged or was shut in due to the war. Iran's production prior to the war was close to 6.0 million b/d. But its present capacity is estimated at only around 3.0 million b/d. Iraq has been rapidly developing reserves but production capacity was also limited due to the war.

Following the cease-fire these two countries began to work on increasing their capacity. Iranian capacity moved up 400,000 b/d to 3.4 million b/d. Iraqi capacity is now estimated at 3.5 million b/d. It was expected that there would be additional capacity added to OPEC in these two countries now that the hostilities have ceased. In fact, one of the key determinants of the level of prices over the next few years was expected to be the production levels adopted by Iran and Iraq. If they added considerably to present production levels, it would put additional downward pressure on prices. The Iraqi invasion of Kuwait may have changed this picture. But if the dispute is ended without destruction of the oil facilities, this will

OECD* PETROLEUM STOCKS

	(Million barrels)								1983/1980		1989/1983	
	1980	1982	1983	1985	1986	1987	1988	1989	Change	% change	Change	% change
Canada	164	136	121	113	111	126	116	114	− 43	−26.2	− 7	− 5.8
France	243	193	153	139	127	127	140	138	− 90	−37.0	−15	− 9.8
Italy	170	179	149	157	155	169	155	164	− 21	−12.4	+ 15	+10.1
Japan	495	484	470	494	509	540	538	577	− 25	− 5.1	+107	+22.8
United Kingdom	168	125	118	123	124	121	112	118	− 50	−29.8	0	0.0
United States	1,392	1,430	1,454	1,519	1,593	1,607	1,597	1,581	+ 62	+ 4.5	+127	+ 8.7
West Germany	319	272	249	233	252	259	266	271	− 70	−21.9	+ 22	+ 8.8
Other OECD	636	557	541	506	547	525	516	512	− 95	−14.9	−29	− 5.4
Total OECD	**3,587**	**3,376**	**3,475**	**3,255**	**3,418**	**3,474**	**3,440**	**3,475**	**−332**	**− 9.3**	**+220**	**+ 6.8**

*Organization for Economic Cooperation & Development.
Source: Energy Information Administration

still be a key determinant of the future price level.

OPEC adopted a very aggressive pricing policy when demand and capacity were in line. It took advantage of the dependency upon oil to fuel economic growth. But because OPEC led the way in boosting prices, when demand fell it resulted in a drop in demand for OPEC oil. The consuming areas looked to other supplies before turning to OPEC for marginal requirements.

OPEC production peaked in 1977 at 31.7 million b/d. This was 64.5% of free-world production. By 1982, for the first time in its history, OPEC production fell below 50% of free-world production. In that year, OPEC output was 19.93 million b/d, 47.4% of free-world output.

By 1984, OPEC crude production had fallen to 18.5 million b/d, a drop of 41.7%. This was only 43% of total free-world production. And in 1985, OPEC production fell another 6.8% to 17.215 million b/d. This was 40.5% of non-communist output, and 29.9% of total world production. OPEC output had fallen 45.7% from the 1977 peak, a drop of 14.465 million b/d. And the drop wasn't because of a drop in available capacity, rather it caused available capacity to be shut in.

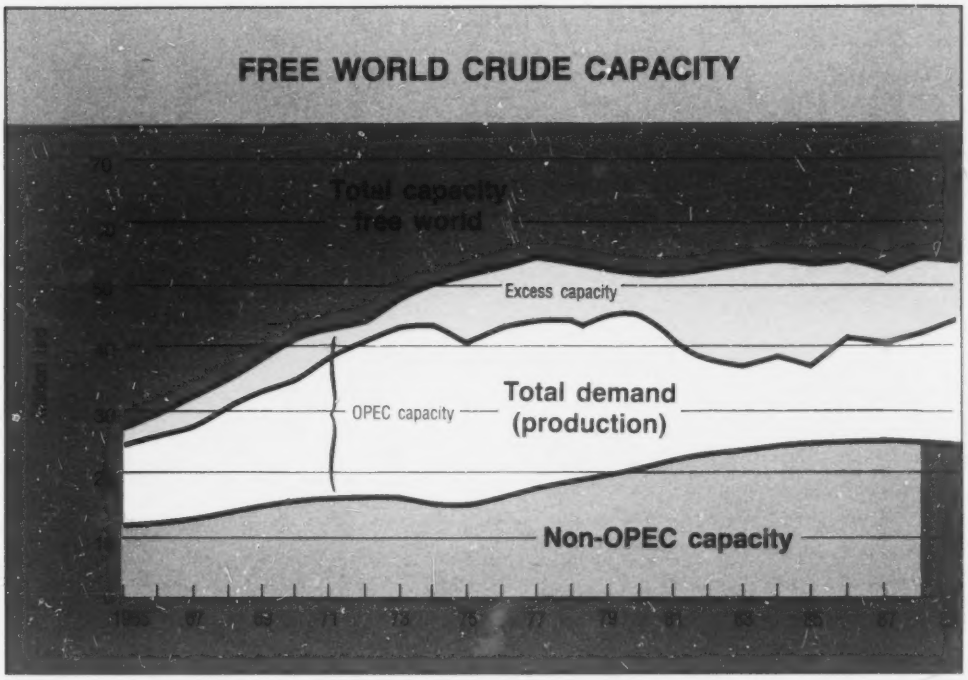
This drastic drop in market share is one of the reasons OPEC tried adopting a market share policy in 1986. And with sharply lower prices, demand for OPEC oil rebound in 1986, jumping up 13.6% to total liquids output of 19.56 million b/d.

But this policy also led to lower prices and lower OPEC revenues. In today's competitive market, it's impossible for OPEC to have it both ways, high market share and high price.

In 1987, OPEC gave up a bit of market share and got slightly higher prices. But they had a great deal of difficulty maintaining production discipline, and in 1988 they pushed more oil into the market and forced prices down again. Discipline returned, at least temporarily, in 1989 and prices moved back up. Prices remained fairly firm in 1990 but did slide as seasonal demand weakened. Prices began to move up when the invasion occurred.

NON-OPEC PRODUCTION. The OPEC countries are not the only crude oil producers in the world. In response to the higher prices engineered by OPEC, the production in non-OPEC, non-communist countries increased steadily from 1975 through 1985. This was a classical economic supply response to substantially higher prices.

Non-OPEC, non-communist production increased 55.5% from 16.255 million b/d in 1975 to 25.275 million b/d in 1985. Obviously, the OPEC-led increase in crude oil prices made oil production economical in a number of other areas of the world. The increases in non-OPEC production occurred throughout the world. Major increases have been recorded in Brazil, Colombia and Mexico in the western hemisphere. Norway and the United Kingdom have boosted production substantially in Western Europe. Elsewhere, there have been large increases in Egypt, Angola,



Malaysia and India. And new production has started in Yemen. A number of these countries have become major exporters of crude oil and are in direct competition with the OPEC exporters.

Non-OPEC production fell slightly in 1986, declining 0.6%, 160,000 b/d, down to 25.09 million b/d. Most of the decline was attributable to the drop in U.S. liquids output. That drop was due to the sharp fall in prices. Much of the U.S. production in older smaller fields is high-cost output. Therefore some production was shut in when prices dipped.

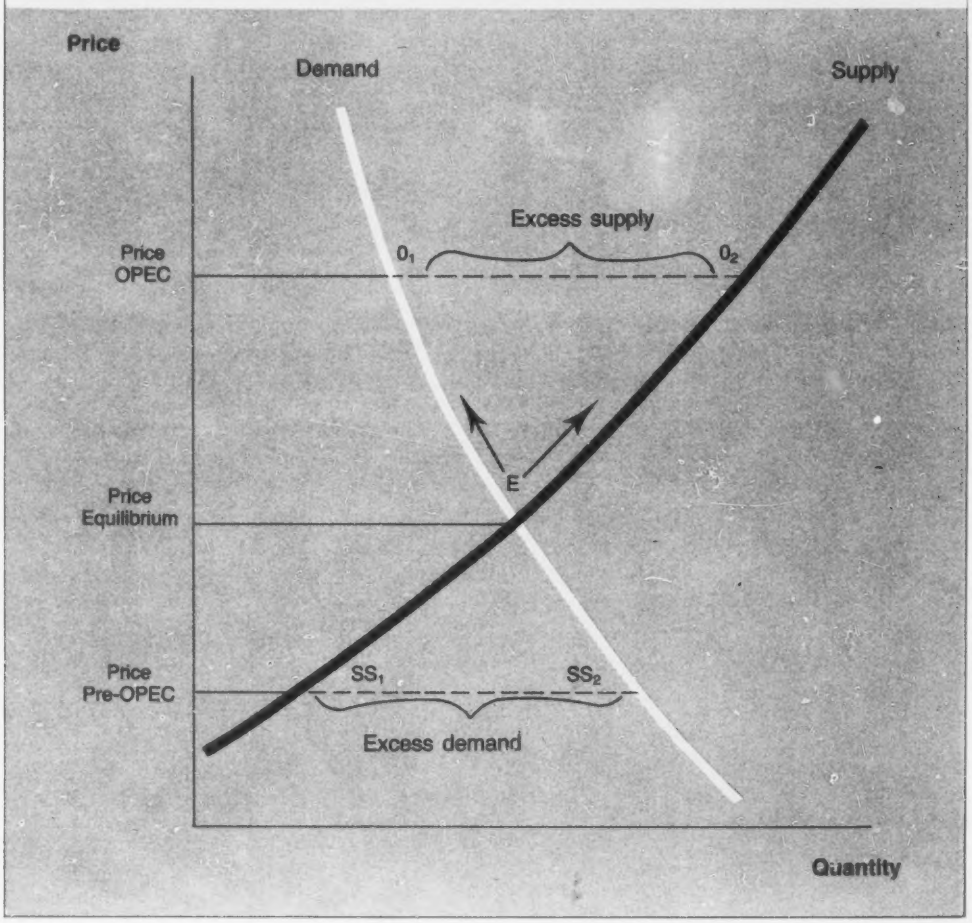
With slipping U.S. production, total non-OPEC output fell another 95,000 b/d in 1987, to 24.995 million b/d. Production rebounded in 1988, increasing 180,000 b/d to 25.175 million b/d. It fell again in 1989 to 24.67 million b/d.

In addition to increasing non-OPEC, non-communist production, the U.S.S.R. was increasing production and exports. A substantial portion of the exports were to the non-communist countries. This added to the crude glut and increased the impact on OPEC.

The U.S.S.R. is the world's largest producer. U.S.S.R. output moved up 26% between 1975 and 1983. Their production fell 3% to 12.15 million b/d in 1985 and there was some question as to how long this level of production could be sustained. However, they did manage to boost production up to 12.56 million b/d in 1986, and 12.775 million b/d in 1987. Production remained close to this level in 1988 at 12.76 million b/d. Production slipped to 12.475 million b/d in 1989 and some major problems have developed. Output is expected to fall below 12 million b/d in 1990.

In addition, the U.S.S.R. has a program to replace internal oil consumption with natural gas. This policy will free more oil for export to the West and continue to add an element to the excess capacity situation in the market-oriented world. This may be changing as U.S.S.R. oil production falls.

THEORETICAL SUPPLY AND DEMAND FOR WORLD OIL



With Chinese production also on the rise, total communist production moved up to 15.87 million b/d in 1987, up 33.4% since 1975. Communist-area production in 1988 was 15.945 million b/d and slipped to 15.675 million b/d in 1989.

THE IMPACT OF EXCESS CAPACITY ON THE OIL MARKET. It is this massive excess capacity, which developed mainly in the OPEC countries, that has put a constant downward pressure on crude oil prices in recent years.

Recognizing the problem caused by the excess capacity, OPEC has tried to stabilize prices by establishing production quotas for individual countries and the group as a whole. However, few of the countries, other than Saudi Arabia, have

WORLDWIDE OIL REFINING THROUGHPUTS

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	% change 89/80
					(1,000 b/cd)						
U.S.	13,520	12,470	11,775	11,685	12,045	12,005	12,715	12,855	13,445	13,555	0.3
Canada	1,915	1,780	1,520	1,455	1,460	1,430	1,395	1,460	1,535	1,550	−19.1
Latin America	6,585	6,700	6,205	5,955	5,845	5,585	5,615	5,665	5,590	5,825	−11.5
Western Europe	12,330	10,970	10,075	9,710	9,790	9,490	10,060	9,960	10,310	10,340	−16.1
U.S.S.R. and Eastern Europe	11,735	12,620	12,720	12,710	12,470	12,185	12,440	12,455	12,485	12,370	5.4
Middle East	2,445	2,205	2,245	2,515	2,665	2,795	2,950	2,970	3,140	3,355	37.2
Africa	1,460	1,525	1,735	1,920	1,975	2,015	2,095	2,170	2,200	2,175	49.0
China	1,430	1,395	1,520	1,600	1,765	1,785	1,865	1,950	2,035	2,150	50.3
Japan	4,015	3,630	3,360	3,255	3,355	3,120	2,990	2,910	2,990	3,175	−20.9
South Asia	705	795	840	880	885	1,020	1,120	1,150	1,160	1,215	72.3
Other Asia	2,400	2,510	2,365	2,410	2,485	2,685	2,800	2,785	2,915	3,090	28.8
Australasia*	640	655	625	605	615	580	580	645	680	695	8.6
TOTAL WORLD	**58,180**	**57,255**	**54,985**	**54,700**	**55,355**	**54,695**	**56,625**	**56,975**	**58,485**	**5,495**	**0.5**
Of which OECD and LDCs†	45,860	43,085	40,590	40,230	40,960	40,555	42,150	42,395	43,790	44,705	−2.5

*Includes Australia and New Zealand.
†Organizaton for Economic Cooperation and Development; and lesser developed countries

Source: British Petroleum

exhibited the production discipline necessary to make the quotas work. The willingness of Saudi Arabia and a few other OPEC members to show some restraint managed to prevent a much earlier free-fall in prices. But even with a substantial effort on the part of Saudi Arabia, it was impossible to stabilize prices. Prices slipped slowly downward from 1981 through 1985.

Trying to prop up and stabilize prices in the face of the overhanging excess capacity is a complex matter. It encompasses the perceived value of oil on the part of the OPEC members, the cost of production, the cost and availability of competing fuels, and the internal politics of the OPEC members.

To present a better view of this problem, the following discussion points out some of the key factors that have an impact on the oil price/production situation. And the discussion will trace some recent OPEC decisions and their impact on the oil markets.

OPEC production, particularly in the Persian Gulf area, is some of the lowest cost in the world. But the aggressive pricing policies of OPEC in the 1970s and 1980s resulted in OPEC oil being the highest priced in the world. Because of the high cost of OPEC oil during that period, the importing countries, whenever possible, replaced OPEC oil supplies with domestic crude or other less-costly, imported crude.

OPEC had become the swing producer, filling the gap between demand and non-OPEC production. All excess capacity, except for some minor exceptions, was thrust upon OPEC. About 47% of installed OPEC capacity, 14 million b/d out of 30 million b/d, was shut in during 1985. This improved slightly in 1986 and 1987 to 12 million b/d out of 30 million b/d, or 40% of installed OPEC capacity shut in. The increase in OPEC production in 1988 reduced the excess capacity to 9.8 million b/d. But this was still 33% of capacity. OPEC production moved up again in 1989 and cut the excess capacity to about 7.4 million b/d, 25% of total capacity.

The OPEC cartel pricing policies resulted in an oil industry turned upside down, with the cheapest production shut in and the most expensive production operating at full capacity.

To get a clearer perspective on what has been happening in the world oil industry and with world oil prices, it might be advantageous to take a look from the viewpoint of classical economic theory.

In classical theory, price is the determinant of supply and demand. When external forces create a situation where there is not equilibrium,

WORLDWIDE OIL REFINING CAPACITIES

Country/Area	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	% change 89/79	% change 89/81
	(1,000 b.c/d)												
North America													
U.S.	17,920	18,250	18,290	16,860	15,865	15,660	15,460	15,460	15,565	15,930	15,695	−12.4	−14.2
Canada	2,315	2,150	2,155	2,260	2,025	2,015	2,075	2,080	2,050	1,890	1,885	−18.6	−12.5
TOTAL NORTH AMERICA	**20,235**	**20,400**	**20,445**	**19,120**	**17,890**	**17,675**	**17,535**	**17,540**	**17,615**	**17,820**	**17,580**	**−13.1**	**−14.0**
Latin America													
Argentina	660	690	690	690	690	680	665	670	690	690	690	4.5	0.0
Brazil	1,230	1,375	1,530	1,530	1,400	1,305	1,305	1,320	1,405	1,405	1,455	18.3	−4.9
Mexico	1,340	1,475	1,525	1,620	1,630	1,680	1,790	1,790	1,790	1,765	1,925	43.7	26.2
Netherlands Antilles	840	840	780	780	780	740	320	320	320	320	320	−61.9	−59.0
Trinidad	465	455	455	375	375	320	260	300	300	300	300	−35.5	−34.1
Venezuela	1,445	1,425	1,405	1,360	1,225	1,225	1,230	1,225	1,200	1,200	1,200	−17.0	−14.6
Others	2,765	2,740	2,680	2,540	2,365	2,140	1,855	1,875	1,870	1,890	2,010	−27.3	−25.0
TOTAL LATIN AMERICA	**8,745**	**9,000**	**9,065**	**8,895**	**8,465**	**8,090**	**7,425**	**7,500**	**7,575**	**7,570**	**7,900**	**−9.7**	**−12.9**
Western Europe													
Belgium	1,020	1,020	965	720	720	720	720	710	705	705	705	−30.9	−26.9
France	3,420	3,320	3,230	2,745	2,370	2,190	2,175	2,040	1,900	1,810	1,700	−50.3	−47.4
Italy	4,205	4,140	3,990	3,500	3,365	2,745	2,585	2,555	2,480	2,345	2,305	−45.2	−42.2
Netherlands	1,815	1,775	1,775	1,590	1,610	1,435	1,380	1,380	1,380	1,395	1,395	−23.1	−21.4
Spain	1,475	1,425	1,550	1,550	1,440	1,440	1,440	1,420	1,420	1,420	1,420	−3.7	−8.4
United Kingdom	2,460	2,460	2,360	2,135	2,105	1,935	1,865	1,835	1,820	1,820	1,805	−26.6	−23.5
West Germany	3,040	3,095	2,955	2,520	2,280	2,115	1,750	1,680	1,650	1,635	1,570	−48.4	−46.9
Others	2,665	2,820	2,830	2,945	2,745	2,705	2,750	2,710	2,830	2,870	2,815	5.6	−0.5
TOTAL WESTERN EUROPE	**20,100**	**20,055**	**19,655**	**17,705**	**16,635**	**15,285**	**14,665**	**14,330**	**14,185**	**14,000**	**13,715**	**−31.8**	**−30.2**
U.S.S.R. and Eastern Europe													
U.S.S.R.	10,500	10,700	11,600	11,750	12,000	12,000	12,000	12,260	12,260	12,260	12,300	17.1	6.0
Eastern Europe	2,660	2,710	2,925	2,970	2,970	2,970	2,970	3,060	3,095	3,190	3,420	28.6	16.9
TOTAL U.S.S.R. & E. EUROPE	**13,160**	**13,410**	**14,525**	**14,720**	**14,970**	**14,970**	**14,970**	**15,320**	**15,355**	**15,450**	**15,720**	**19.5**	**8.2**
Middle East													
Bahrain	250	250	250	250	250	250	250	250	250	250	255	2.0	2.0
Iran	1,045	1,225	625	625	600	530	530	530	530	530	530	−49.3	−15.2
Iraq	265	265	265	265	200	300	320	320	320	320	320	20.8	20.8
Kuwait	575	575	530	545	590	590	630	620	630	815	820	42.6	54.7
Saudi Arabia	635	495	660	965	865	865	1,115	1,125	1,375	1,375	1,005	58.3	52.3
Others	770	755	920	1,015	1,055	980	965	1,005	1,060	1,075	1,075	39.6	16.8
TOTAL MIDDLE EAST	**3,540**	**3,565**	**3,250**	**3,565**	**3,560**	**3,515**	**3,810**	**3,850**	**4,165**	**4,365**	**4,005**	**13.1**	**23.2**
Africa	2,000	2,060	2,035	2,355	2,340	2,540	2,555	2,550	2,630	2,810	2,835	41.8	39.3
Asia & Australasia													
China	1,900	1,900	1,810	2,000	2,050	2,150	2,150	2,170	2,230	2,340	2,470	30.0	36.5
Indonesia	535	515	515	515	760	760	780	780	780	780	780	45.8	51.5
Japan	5,285	5,675	5,675	5,500	4,975	4,975	4,975	4,705	4,565	4,365	4,200	−20.5	−26.0
Singapore	1,040	1,020	1,020	1,020	1,020	1,020	1,020	960	860	930	1,015	−2.4	−0.5
South Asia	825	870	885	995	1,020	995	1,150	1,225	1,295	1,285	1,310	58.8	48.0
Other Asia	1,850	1,930	1,980	1,980	1,980	2,160	2,045	2,145	2,145	2,070	2,125	14.9	7.3
Australasia*	800	810	815	815	815	785	705	740	730	745	745	−6.9	−8.6
TOTAL ASIA & AUSTRALASIA	**12,235**	**12,720**	**12,700**	**12,825**	**12,620**	**12,845**	**12,825**	**12,725**	**12,505**	**12,515**	**12,645**	**3.4**	**−0.4**
TOTAL WORLD	**80,015**	**81,210**	**81,675**	**79,185**	**76,480**	**74,920**	**72,785**	**73,815**	**74,130**	**74,530**	**74,400**	**−7.0**	**−8.9**
Of which OECD & LDCs†	64,805	65,715	65,140	62,255	59,260	57,600	56,475	56,135	56,345	56,550	55,900	−13.9	−14.2

*Includes Australia and New Zealand.
†Organizaiton for Economic Cooperation and Development; and lesser developed countries
Source: British Petroleum

i.e., demand and supply do not meet at a market clearing price, then there are economic forces at work attempting to move the market toward equilibrium.

Prior to the establishment of OPEC, there was some justification in assuming that the international oil companies held the price below the equilibrium price. This created a situation of excess demand. The oil companies met demand by concentrating on production. And pricing was based on current production costs. Little emphasis was given to the long-run value of reserves in the ground. The result was a rapid increase in demand as cheap oil energy fueled economic expansion worldwide.

When OPEC gained control over produc-

tion, they placed more emphasis on the long-term value and life of their oil reserves. They attempted to maximize immediate return rather than output. And they searched for the price level that the market would bear. To a certain extent, OPEC was using the world as a large economic laboratory to test the elasticity of demand for crude oil. The result of OPEC's pricing policy was a reduction in demand and increased supply, netting out to an excess supply situation.

However, market forces began to take hold and movement started toward re-establishing equilibrium. This movement took the form of falling prices, increased demand and a reduction in the rate of increase in the non-OPEC crude supply.

A brief review of what happened to prices over the past 15 years will help clarify this classical description. The official posted price of the OPEC market crude, Saudi Arabian light, was boosted 294.2% from $2.75/bbl in 1973 to $10.84/bbl in 1974. The demand response was minimal at that time, since oil had been underpriced.

Then the price was moved up slowly to $12.70/bbl in 1978, an additional increase of 17.2%. However, because of the sharp increase in the rate of inflation, the real price actually fell during this period. Therefore demand for crude oil continued to move up even though the crude oil price had increased substantially.

Demand is more responsive to the real price than the actual price since economic decisions to consume are based on the relative cost of an item compared to other necessary purchases.

Since demand was still rising, OPEC decided to raise prices again and test the market. This time they boosted prices sharply from $12.70/bbl in 1978 to $34.00/bbl at the end of 1981, an additional increase of 167.7%. The overall price increase from 1973 through 1981 was $31.25/bbl, up 1,136.4%.

A price increase of that magnitude was bound to attract the attention of oil consumers. Demand reacted to this price increase. Conservation, fuel switching to other energy and a slowdown in economic activity led to a 19% drop in production in the non-communist world between 1979 and 1983. This drop in demand for oil, coupled with the increase in non-OPEC production, resulted in the huge excess capacity in the OPEC countries.

This excess capacity put substantial downward pressure on prices. The official OPEC market crude price fell to $28/bbl in 1985, a reduction of 17.6% from the peak $34/bbl level. The average spot market price fell from $35.69/bbl in 1980 to an estimated $27.80/bbl in 1984, a drop of 22.1%.

This fall in prices also got a reaction from fuel consumers. Free world demand responded to this sharp drop in prices, and moved up 2.1% in 1984.

Another phenomenon occurred along with the development of a huge excess capacity. The growth in excess capacity led to a shift in trading from contract to the spot market. With crude readily available there was less need of or advantage in long-term contracts.

When prices moved up sharply in 1979–81, spot market prices were well above official prices. The average spot market price in 1979 was $12.60/bbl higher than the contract price. This difference undoubtedly prompted OPEC to push up the official price for their crude oil. With the development of the excess capacity, spot market prices fell below official prices and led to the drop in official prices.

The volume of crude traded in the spot market grew substantially from 1981 to 1985. By 1985, the vast majority of transactions were spot market transactions or contract trades based on spot market prices. There has been some attempt to re-establish contract prices, but the volatile nature of prices has made this impossible. Instead, what has been established are crude supply contracts with the price based on some current market price indicator, such as spot market or futures market prices.

In addition to the shift to spot market

FREE WORLD ACTIVE RIG COUNT

(Annual average)

Region	1979 Total	1980 Total	1981 Total	1982 Total	1983 Total	1984 Total	1985 Total	1986 Total	1987 Total	1988 Land	1988 Off.	1988 Total	1989 Land	1989 Off.	1989 Total
Canada	339	401	263	200	201	259	311	178	181	193	2	195	129	1	130
United States	2,176	2,910	3,969	3,117	2,229	2,429	1,976	970	936	813	124	937	765	105	870
North America	**2,515**	**3,311**	**4,232**	**3,317**	**2,430**	**2,688**	**2,287**	**1,148**	**1,117**	**1,006**	**126**	**1,132**	**894**	**106**	**1,000**
Argentina	63	76	70	67	73	82	81	47	61	63	0	63	54	1	55
Brazil	60	72	81	94	83	70	76	77	60	28	11	39	20	7	27
Mexico	205	215	218	202	187	196	196	163	143	121	34	155	70	34	104
Venezuela	47	52	63	69	41	30	33	29	18	15	10	25	18	10	28
Others	65	66	89	90	67	61	57	55	56	40	13	53	36	10	46
Latin America	**440**	**481**	**521**	**522**	**451**	**439**	**443**	**371**	**338**	**267**	**68**	**335**	**198**	**62**	**260**
India	40	43	44	50	56	57	63	70	116	106	25	131	111	25	136
Indonesia	66	77	86	92	88	82	80	52	37	33	11	44	36	10	46
Others	111	122	125	135	131	119	118	102	85	59	27	86	58	25	83
Far East	**217**	**242**	**255**	**277**	**275**	**258**	**261**	**234**	**238**	**198**	**63**	**261**	**205**	**60**	**265**
Algeria	109	111	91	81	54	27	35	41	40	32	0	32	24	0	24
Libya	33	41	33	31	24	26	30	20	12	14	2	16	13	4	17
Nigeria	18	20	23	27	17	11	10	10	11	8	6	14	10	4	14
Others	41	47	66	70	52	41	43	26	27	11	21	32	12	16	28
Africa	**201**	**219**	**213**	**209**	**147**	**105**	**118**	**97**	**90**	**65**	**29**	**94**	**59**	**24**	**83**
Germany, Fed. Rep.	21	22	26	31	25	19	20	19	12	9	0	9	8	0	8
Italy	21	19	32	38	26	26	40	33	26	17	7	24	17	5	22
United Kingdom	34	48	58	58	42	60	63	43	44	5	52	57	4	42	46
Others	76	90	102	110	92	98	110	89	73	47	32	79	44	27	71
Western Europe	**152**	**179**	**218**	**237**	**185**	**203**	**233**	**184**	**155**	**78**	**91**	**169**	**73**	**74**	**147**
Abu Dhabi	20	23	31	41	35	29	21	15	9	3	5	8	2	4	6
Egypt	21	26	27	36	35	36	37	33	23	11	10	21	7	12	19
Saudi Arabia	22	25	29	29	26	16	11	6	5	4	1	5	2	1	3
Turkey	9	24	26	34	26	24	25	27	26	21	1	22	24	0	24
Others	72	79	57	60	84	92	107	97	76	87	4	91	92	5	97
Middle East	**144**	**177**	**170**	**200**	**206**	**197**	**201**	**178**	**139**	**126**	**21**	**147**	**127**	**22**	**149**
Australia	11	15	23	32	25	34	31	15	16	13	5	18	7	7	14
Others	2	3	3	2	3	3	6	5	5	3	1	4	3	1	4
South Pacific	**13**	**18**	**26**	**34**	**28**	**37**	**37**	**20**	**21**	**16**	**6**	**22**	**10**	**8**	**18**
Total Free World	**3,682**	**4,627**	**5,635**	**4,796**	**3,722**	**3,927**	**3,580**	**2,232**	**2,098**	**1,756**	**404**	**2,160**	**1,566**	**356**	**1,922**
Total excl. North America	**1,167**	**1,316**	**1,403**	**1,479**	**1,292**	**1,239**	**1,293**	**1,084**	**981**	**750**	**278**	**1,028**	**672**	**250**	**922**

Source: Baker Hughes Inc.

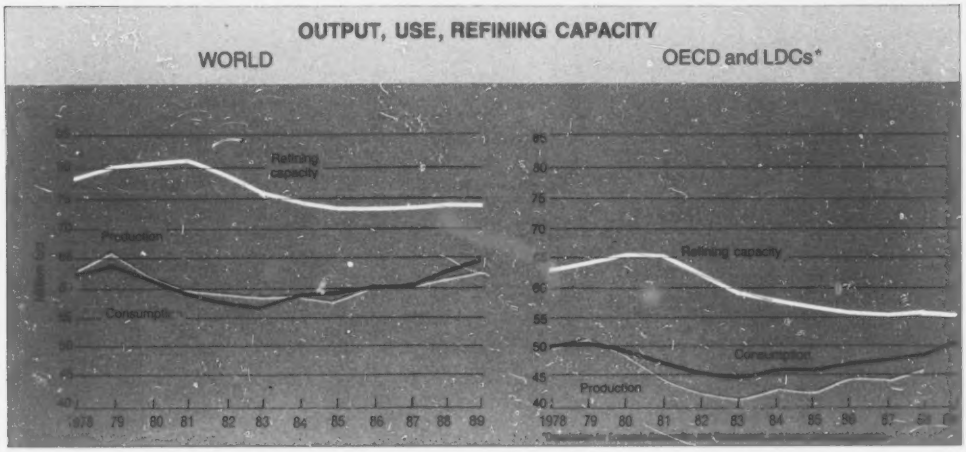
trading, the more speculative nature of crude trading and prices resulted in the development of a futures market. This market has grown rapidly, and is today one of the most watched indicators in the oil industry.

In five years, the number of crude oil contracts traded on the New York Mercantile Exchange took off, with 350 million bbl in 1983, 1,840 million bbl in 1984, 3,981 million bbl in 1985, 8,314 million bbl in 1986, 14,582 million bbl in 1987, 18,518 million bbl in 1988, and 20,665 million bbl in 1989.

With the movement to spot market transactions, and the development of the futures market, OPEC lost a lot of control over pricing. They had a market with higher oil prices but no longer the control over prices the international oil companies once had.

In an attempt to prevent a collapse of prices, OPEC established production quotas for each member country. OPEC set a production quota in 1983 of 17.5 million b/d. However, prices continued to slide and the production quota was reduced to 16 million b/d in 1984. There was considerable cheating, with a number of OPEC countries producing above their quotas.

At that time Saudi Arabia was willing to play the role of swing producer and cut production



sharply in order to support the worldwide price. Saudi Arabian production fell 6.39 million b/d, 64%, from 9.99 million b/d in 1980 to 3.6 million b/d in 1985. Other OPEC producers showed some production restraint, and the result was a sufficient reduction in total production to prevent a free-fall in prices.

In order to prop up prices, Saudi Arabia was forced to shut in a substantial volume of production. After awhile it 'becameapparent that they were absorbing a disproportionate percentage of the production cutback that was required to support prices.

In the summer of 1985, Saudi production temporarily dipped below 2 million b/d in their role of swing producer. And it became apparent that with expected weak demand in 1986, their production would fall even further if they continued to be the supply source of last resort.

So in the fall of 1985 the Saudis unilaterally arranged, with several selected purchasers, to sell their oil using a new net-back pricing arrangement. They were willing to accept a lower price for their crude oil that was based on the net-back value of the crude oil after product sales and refining. This was done by the Saudis in order to increase their share of the crude oil market and to send a message to the other OPEC producers: a message that they would no longer carry the entire burden of supporting prices. They abandoned the role of swing producer and have never returned to it.

In a subsequent meeting in 1985, OPEC policy was also changed to one aimed at regaining market share rather than supporting prices. This turned out to be a disaster. This shift in OPEC policy brought the full weight of the excess crude capacity bearing down on worldwide crude oil prices. The result was a collapse in the price of crude oil in early 1986, when winter demand began to slacken.

The average price of world export crude fell from $27.10/bbl at the end of 1985 to a low of $9.35/bbl the first week of August 1986, a drop of 65%. This did stimulate demand for OPEC oil, and did curtail investment in, and in some cases production of, competing high-cost oil. OPEC did achieve the goal of increased market share. But there was a huge cost associated with the increase in market share, since the drop in prices far exceeded the increase in demand for OPEC oil.

OPEC found out that there was a tremen-

dous cost to pay for gaining market share at the expense of the price level. August production in 1986 at 21.028 million b/d was up 38.6% over August 1985. And cumulative production for the first eight months of 1986 was up 19.9% from 1985. But prices had fallen 65% and it was obvious that increased volume could not make up for lost revenue due to lower prices. If OPEC wanted increased market share, that increased share would be at the cost of substantially lower revenues.

The total value of OPEC crude exports had fallen from $282 billion in 1980 to $132 billion in 1985, a drop of 53.4%. Revenues for 1986 fell another 42% to $77 billion. The policy of trying to gain a greater market share cost OPEC $56 billion in revenue. This was sufficient incentive to establish a workable quota agreement.

With the new quotas, OPEC production dropped in 1987, about 2.7%, but estimated revenues were up substantially. Estimated revenues increased about 13% to $87 billion.

OPEC wasn't able to establish group production discipline, Saudi Arabia abandoned the role of sole swing producer, and the result was a collapse in prices in the spring of 1986. OPEC supposedly learned a lesson from this experience. Quotas were re-established and prices moved back up in 1987.

But the lesson wasn't learned very well and 1988 in many ways turned out to be a repeat of 1986, although not quite as severe. In 1988, as in 1986, OPEC found it very difficult to sustain production discipline with that huge excess production capacity readily available. In 1988, overproduction again weakened prices. A number of OPEC countries boosted output over the quota and prices fell. The average export price of OPEC crude oil fell from $16.35/bbl in January of 1988 to $10.75/bbl in October. It appeared that the lesson of market economics had to be learned all over again.

OPEC established new, more realistic production quotas starting in January 1989. And some of the countries that were overproducing exhibited sufficient discipline to tighten the market and help firm up prices. In addition, OPEC was helped out by rising demand that was stimulated by the low prices. This helped clear the market and support prices at a higher level. Prices moved up to $15.04/bbl in January 1989 and to $18.24/bbl in April. For the remainder of the year, export prices remained relatively stable, moving between $15.50/bbl and $17.50/bbl. This continued through the first half of 1990. There was some overproduction and prices weakened but did not collapse.

OPEC REFINING CAPACITY

Country	1980	(Dec 31) 1982	1988	Change 1988-1982	% change 1988/1982
	(1,000 b/cd)				
Algeria	471.2	471.2	471.2	—	—
Ecuador	94.5	94.5	133.0	38.5	40.7
Gabon	44.0	44.0	21.0	−23.0	−52.3
Indonesia	473.4	473.4	738.7	265.3	56.0
Iran	1,320.0	670.0	615.0	−55.0	−8.2
Iraq	305.5	215.5	365.5	150.0	69.6
Kuwait	594.0	594.0	670.0	76.0	12.8
Libya	117.0	117.0	342.0	225.0	192.3
Nigeria	234.0	234.0	265.5	31.5	13.5
Qatar	10.5	13.0	63.0	50.0	384.6
Saudi Arabia	878.0	765.0	1,490.0	725.0	94.8
United Arab Emirates	13.5	121.5	162.0	40.5	33.3
Venezuela	1,444.9	1,323.1	1,201.1	−122.0	−9.2
Total OPEC	**6,000.5**	**5,136.2**	**6,538.0**	**1,401.8**	**27.3**

Source: OPEC Statistical Bulletin

PRICING CRUDE OIL. It appears quite apparent that the key to establishing a price for crude, or just stabilizing crude prices, is the OPEC adherence to a reasonable quota. This is evident from the events of 1986, 1987, 1988 and 1989, when crude prices moved through a couple of major cycles.

OPEC abandoned their attempt to increase world market share by re-establishing production quotas in late 1986. First they adopted a set of temporary emergency quotas in September 1986, to stop the free-fall in crude prices. And then they adopted a more formal set of quotas at the end of 1986 to help sustain a higher price level.

The average price of OPEC export crudes

WORLDWIDE EXCESS PRODUCTIVE CAPACITY

	Production			Productive capacity*			Excess capacity				
	OPEC	Non-OPEC	Total Non-Comm	OPEC	Non-OPEC	Total Non-Comm	OPEC	Non-OPEC	Total Non-Comm	– % of – total capacity	total production
	(1,000 b/d)										
1961	9,364	9,319	18,683	10,150	10,050	20,200	786	731	1,517	7.51	8.12
1962	10,508	9,663	20,171	11,350	10,450	21,800	842	787	1,629	7.47	8.08
1963	11,514	10,036	21,550	12,450	10,850	23,300	936	814	1,750	7.51	8.12
1964	12,984	10,206	23,190	14,050	11,050	25,100	1,066	844	1,910	7.61	8.24
1965	14,339	10,552	24,891	15,500	11,400	26,900	1,161	848	2,009	7.47	8.07
1966	15,770	11,235	27,005	17,050	12,150	29,200	1,280	915	2,195	7.52	8.13
1967	16,850	12,155	29,005	18,200	13,150	31,350	1,350	995	2,345	7.48	8.08
1968	18,786	13,114	31,900	20,300	14,200	34,500	1,514	1,086	2,600	7.54	8.15
1969	20,907	13,569	34,476	22,600	14,650	37,250	1,693	1,081	2,774	7.45	8.05
1970	23,413	14,515	37,928	25,300	15,700	41,000	1,887	1,185	3,072	7.49	8.10
1971	25,326	14,575	39,901	27,400	15,750	43,150	2,074	1,175	3,249	7.53	8.14
1972	27,094	14,845	41,939	29,300	16,050	45,350	2,206	1,205	3,411	7.52	8.13
1973	30,989	14,942	45,931	33,500	16,150	49,650	2,511	1,208	3,719	7.49	8.10
1974	30,729	14,593	45,322	34,800	15,750	50,550	4,071	1,157	5,228	10.34	11.54
1975	27,155	14,418	41,573	36,100	15,600	51,700	8,945	1,182	10,127	19.59	24.36
1976	30,738	14,548	45,286	37,400	15,750	53,150	6,662	1,201	7,863	14.79	17.36
1977	31,278	15,595	46,873	38,700	16,850	55,550	7,422	1,255	8,677	15.62	18.51
1978	29,805	17,304	47,109	36,480	18,700	55,180	6,675	1,396	8,071	14.63	17.13
1979	30,928	17,708	48,636	34,260	19,150	53,410	3,332	1,442	4,774	8.94	9.82
1980	26,890	18,310	45,200	32,730	19,800	52,530	5,846	1,484	7,330	13.95	16.21
1981	22,624	18,853	41,477	31,200	20,400	51,600	8,576	1,547	10,123	19.62	24.41
1982	18,584	19,768	38,352	31,200	21,400	52,600	12,616	1,632	14,248	27.09	37.15
1983	17,317	20,718	38,035	31,200	22,400	53,600	13,883	1,682	15,565	29.04	40.92
1984	17,442	21,922	39,364	31,000	23,700	54,700	13,558	1,778	15,336	28.04	38.96
1985	16,039	22,727	38,766	30,000	24,400	54,400	13,961	1,673	15,634	28.74	40.33
1986	18,074	22,443	40,517	30,000	24,550	54,550	11,926	2,107	14,033	25.73	34.63
1987	17,801	22,532	40,333	29,500	24,800	54,300	11,699	2,268	13,967	25.72	34.63
1988	19,665	22,744	42,409	29,500	24,700	54,200	9,835	1,956	11,791	21.75	27.80
1989	22,048	22,333	44,381	29,000	24,500	53,500	6,952	2,167	9,119	17.04	20.55

*Estimated total available capacity

OPEC PRODUCTION QUOTAS

Country	1984* quota	1984 production	1986 quota	1986 production	1989* quota	1989 production
	(1,000 b/d)					
Algeria	663	608	667	641	771	714
Ecuador	183	258	221	305	254	279
Gabon	137	150	159	175	184	211
Indonesia	1,189	1,423	1,190	1,138	1,374	1,235
Iran	2,300	2,174	2,369	2,240	2,926	2,947
Iraq	1,200	1,210	1,540	2,688	2,926	2,897
Kuwait	900	945	996	1,335	1,149	1,593
Libya	990	1,091	996	1,025	1,149	1,130
Neutral Zone	†	439	†	313	†	397
Nigeria	1,300	1,414	1,301	1,390	1,501	1,672
Qatar	280	396	299	346	346	387
Saudi Arabia	4,353	4,464	4,343	4,946	5,014	4,995
United Arab Emirates	950	1,159	948	1,474	1,094	1,866
Venezuela	1,555	1,711	1,571	1,649	1,812	1,725
Total	**16,000**	**17,442**	**16,600**	**19,665**	**20,500**	**22,048**

*Production quotas did not apply for full year. †Quota does not apply to Neutral Zone. Production shared by Kuwait and Saudi Arabia.

Source: OPEC and Author's estimates

fell from $27.81/bbl at year end 1985, to $9.59/bbl in August 1986, during the OPEC experiment with attempting to increase market share. When OPEC announced that they were adopting temporary quotas, the price moved back up to $12.50/bbl, and remained between $12.30/bbl and $14.70/bbl for the remainder of 1986. Following the adoption of formal quotas in December 1986, the average price of OPEC export crude moved up over $17/bbl. And the price stayed above $17/bbl for all of 1987. The key to the higher price level was the adoption and adherence to the quotas, and the abandonment of netback pricing.

Under netback contracts, the price of the crude traded is based upon the value or selling prices of the refined products. The value of the products that can be obtained from the specific type of crude oil are determined by the sales price

during a specified time period. From this value are deducted the costs associated with refining the products, transporting the crude and a specified processing fee or refiner margin. The remainder is the netback value or price of the crude, and represents the amount remitted to the producer. Netback pricing shifts a great deal, if not all, of the price risk in the market to the producer.

Under netback pricing, refiners had a great deal of incentive to try to move large volumes of product by price competition. Under most netback formulas, refiners were virtually guaranteed a profitable margin on each barrel. So the incentive was for the refiner to increase the volume sold. This led to rapidly declining prices which boosted product demand and demand for crude oil.

For a time it appeared that OPEC was trying to reestablish the old posted price system. But as expected, not many purchasers were willing to commit to any long-term contracts in the current volatile market.

OPEC export prices were rather stable for an extended period in 1987, but this was due more to market conditions rather than to an acceptance of posted prices by the crude purchasers. The adherence to production levels close to the adopted OPEC quotas brought supply and demand close to equilibrium and stabilized prices.

OPEC may have regained some control over the market and the price of oil in 1987. But that control was dependent upon their ability to establish a quota that would tighten supply in the market. And it was dependent upon OPEC countries having the long-term discipline to constrain production levels.

They flunked the test in 1988, by overproducing and driving down the price. And again it cost them revenue.

As in the past, the key to future price stability will be OPEC production discipline and the selection of a quota that can sustain equilibrium between supply and demand. OPEC managed to do this fairly well in 1989, but they were helped out by higher than expected worldwide demand. The production discipline eroded somewhat in the first half of 1990 and prices slipped. OPEC was attempting to reestablish some quota discipline when the Iraqi invasion of Kuwait took place.

WORLDWIDE EXPORT CRUDE OIL PRICES

Official Sales and Term Contract Prices (Dollars per barrel - 1 January)

Year	Saudi Arabia Arabian Light 34°	Nigeria Bonny Light 37°	United Kingdom Brent 38°	Mexico Isthmus 33°	U.S.S.R. Export Blend 32°
1979	13.34	14.80	15.70	14.10	13.20
1980	26.00	29.97	26.02	32.00	33.20
1981	32.00	40.00	39.25	38.50	39.25
1982	34.00	36.50	36.60	35.00	35.49
1983	34.00	35.50	33.50	32.50	31.20
1984	29.00	30.00	30.00	29.00	28.60
1985	29.00	28.00	28.65	29.00	28.00
1986	28.00	28.65	26.00	26.21	28.15
1987	16.15	17.13	18.25	17.00	18.30
1988	17.52	18.92	18.00	14.83	15.80
1989	13.15	15.05	15.80	14.53	14.55
1990	18.40	21.20	21.00	19.90	20.25

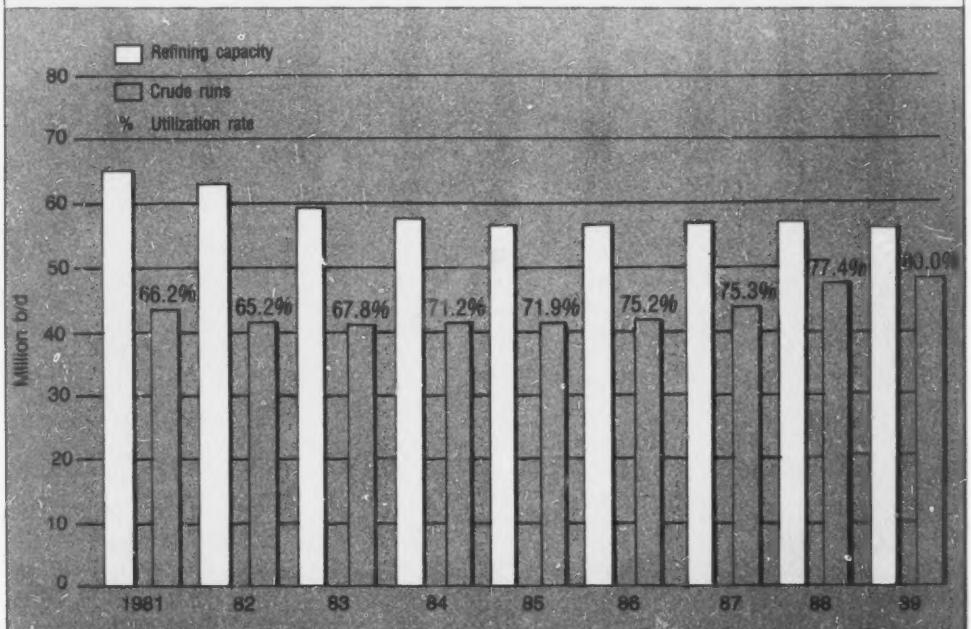
Source: Energy Information Administration

SUPPLY VULNERABILITY. In past editions it was pointed out that the outlook is based upon expectations due to economic forces and doesn't attempt to forecast political events. It also pointed out that a political upheaval would have some impact on worldwide supply. There now is a political situation in the Middle East that is having just such an impact on worldwide supply.

Of most concern in the past has been the possible closing ofthe Strait of Hormuz due to some conflict in that area. This was of particular concern during the Iran-Iraq war since there was considerable action directed at tanker traffic during that conflict. With the cease-fire between Iran and Iraq, the probability of a closure of the Strait was reduced substantially. This concern has been raised again because of the possibility of another conflict erupting in that area.

Dependency upon imports through the Strait of Hormuz had been reduced in recent years due to reduced worldwide imports and alternative pipeline routes that bypass the Strait. However, imports are on the rise again and this will add to

OECD and LDCs* REFINING CAPACITY AND CRUDE RUNS



	1981	82	83	84	85	86	87	88	89
Refining capacity	65.1	62.3	59.3	57.6	56.5	56.1	56.3	56.6	55.9
Crude runs	43.1	40.6	40.2	41.0	40.6	42.2	42.4	43.8	44.7

*Organization for Economic Cooperation and Development and lesser developed countries.

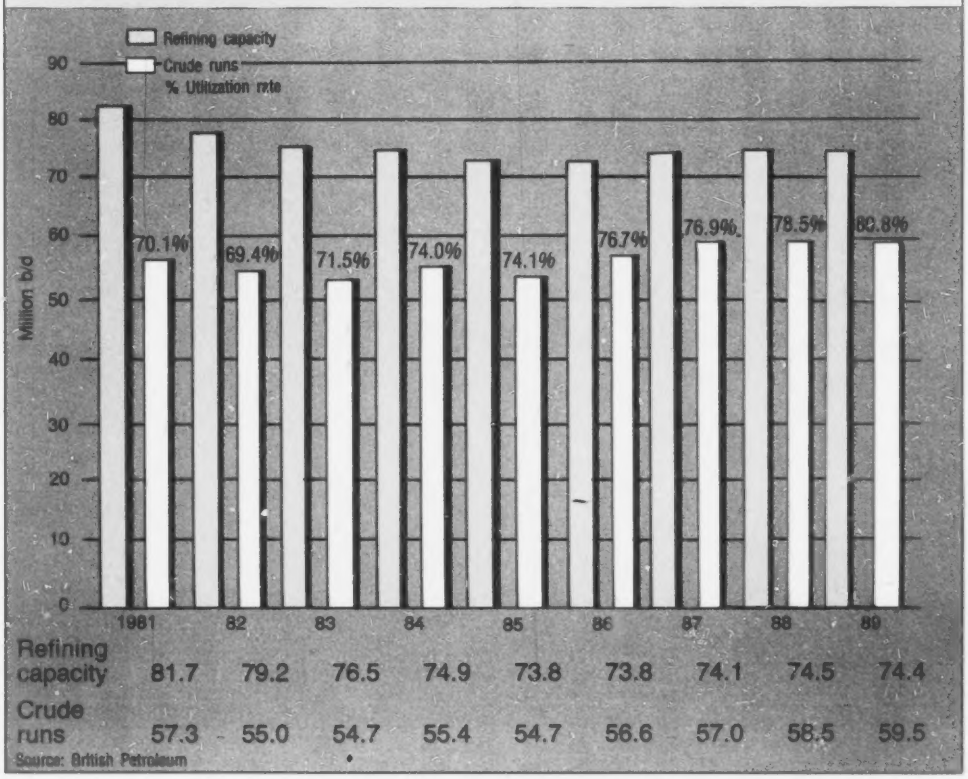
Source: British Petroleum

vulnerability. Four years ago, 8.4 million b/d, 36% of free-world imports, were coming through the Strait. At the present time, about 6.5 million b/d are being exported via the Strait of Hormuz. The non-communist total imports are somewhere close to 27 million b/d. Therefore, approximately 25% of total non-communist import requirements would be affected if the Strait was closed.

Saudi Arabia has increased the capacity of their pipeline system to the Red Sea, currently housing the capacity to move close to 4 million b/d via their pipeline system. If they fully utilized this capacity it would substantially reduce the flow through the Strait.

Although it appears that vulnerability has been reduced because of the end to the war, this will continue to remain a strategic channel for world oil supply. U.S. imports are increasing rapidly, which is boosting the volume of crude and products in international trade. Even though some alternative routes have been developed, it is probable that the amount of crude moving through the

TOTAL WORLD REFINING CAPACITY AND CRUDE RUNS



	1981	82	83	84	85	86	87	88	89
Refining capacity	81.7	79.2	76.5	74.9	73.8	73.8	74.1	74.5	74.4
Crude runs	57.3	55.0	54.7	55.4	54.7	56.6	57.0	58.5	59.5

Source: British Petroleum

Strait will increase. Iran is expected to boost output and Iraq was planning to re-establish an export terminal in the Gulf. These moves add to the volumes moving through the Strait.

If the Strait was closed for any reason, the impact on prices would depend upon the perceived length of time it would be closed. If it appeared that the closing was only temporary, the industrial countries and international oil companies might simply draw down stock levels to meet the demand. However, industry stock levels are presently quite low and do not offer much of a buffer against a major supply disruption. On the other hand, strategic government stocks might be used if there were a temporary disruption.

Although still an area of vulnerability, there is presently little thought given to a potential closing, and it doesn't appear to have much impact on industry decisions.

The invasion of Kuwait by Iraq and the subsequent embargo took a volume of oil out of the market that is close to the volumes moving

through the Strait. But in this latter instance the vulnerability was potentially much higher. There was a reasonable fear that other oil production in the Persian Gulf could be threatened by Iraq. Saudi Arabia and the United Arab Emirates represented another 7.3 million b/d of production. Combined with output from Iraq and Kuwait, this would be 12 million b/d that could be lost to the world market. A production loss of this magnitude would bring chaos to the world industrial economies. The adjustment required would be extremely costly.

EXPLORATION. The search for oil throughout the non-communist world, outside the United States, has not been fluctuating as wildly as crude oil prices. Oil importing countries find it financially advantageous to develop their own crude capacity. In addition, the international oil companies have found that there is substantially more profit margin in equity crude than in crude purchased from OPEC exporters. So they have continued the search in those areas where they can obtain favorable and profitable exploration/development agreements.

The result has been an active drilling rig count, outside the U.S. and Canada, that has held up fairly well during the recent period of falling or wildly fluctuating prices.

The number of active drilling rigs outside the U.S. and Canada peaked in 1982 at 1,479. The active rig count fell to 1,292 in 1973, and 1,239 in 1984, but then went back up to 1,293 in 1985. The rig count did fall 16.2% to an average 1,084 in 1986. However, this was less than half of the 35–40% drop in average crude oil prices. The count did slip again in 1987, to an average of 981 for the year. But by year end it had moved back up to 1,050. And the average for 1988 increased to 1,028. This is comparable to 1978 when the count averaged 1,086. The international rig count fell again in 1989 and averaged only 922. Drilling dropped sharply in a few of the countries with internal financial problems.

Compared to the peak year of 1982, the international rig count for 1989 was down 37.7%. The price of crude oil on the other hand was down 50%. The rig count in mid-1990 was up from the year before and expectations are that it will average slightly higher for the year. The surge in prices at year end might act to stimulate additional drilling.

Until the collapse in prices in 1986, one of the major reasons for the high level of activity in the face of declining demand was the relatively high price of oil. Since the increase in the price of oil far-surpassed the general rate of inflation over the past decade, the profit margin on projects had increased considerably. Previously uneconomic or marginal fields were being developed throughout the world, and huge import bills encouraged countries without sufficient production to stimulate exploration activities.

One major result of this high level of exploration activity has been the prevention of a major decline in worldwide crude reserves. In fact, coupled with the decline in demand/production, the increased exploration has resulted in an increase in reserves.

Looking to the future, as oil becomes more difficult to find,particularly in large quantities, activity must increase in order to maintain reserves. This is particularly true in the non-OPEC areas. And the level of activity will be sustained and increased only if the price level moves up.

However, this does not appear to be an immediate problem. Total worldwide crude oil reserves were increased substantially during 1987, 1988 and 1989. Reserves at the start of 1989 were up 43.6%, an increase of 304 billion barrels, from three years earlier. Reserves as of January 1, 1990, were 1,002 billion barrels. Huge revisions and additions were made by five OPEC countries: Venezuela, United Arab Emirates, Iraq, Iran and Saudi Arabia. This accounted for most of the massive increase.

One of the results of this substantial addition is that worldwide reserves at the start of 1990

WORLDWIDE GAS RESERVES

	Jan. 1					Change	% change
	1973	1978	1983	1988	1990	1990-1973	1990/1973
	(Billion cu ft)						
Australia	36,236	32,000	17,768	18,610	16,467	−19,769	−54.6
India	2,300	3,500	14,508	17,550	22,973	+20,673	+898.8
Indonesia	5,500	24,000	29,600	73,000	87,015	+81,515	+1,482.1
Malaysia	*10,000	17,000	34,000	52,200	51,900	+41,900	+419.0
Pakistan	16,000	15,500	18,540	22,400	18,000	+2,000	+12.5
Thailand	—	4,500	11,000	3,720	6,910	+6,910	—
Others	31,200	31,225	20,831	37,320	44,766	+13,566	+43.5
Total Asia-Pacific	**101,236**	**122,725**	**146,247**	**224,800**	**248,031**	**+146,795**	**+145.0**
Netherlands	88,000	60,000	51,920	64,100	61,100	−26,900	−30.6
Norway	15,000	20,000	58,000	105,940	82,160	+67,160	+447.7
United Kingdom	45,000	29,000	25,400	22,000	20,836	−24,164	−53.7
Others	30,400	29,190	21,416	26,140	27,818	−2,582	−8.5
Total Western Europe	**178,400**	**138,190**	**156,736**	**218,180**	**191,914**	**+13,514**	**+7.6**
Abu Dhabi	12,000	20,000	19,260	183,500	182,900	+170,900	+1,424.2
Iran	200,000	500,000	482,600	489,400	500,000	+300,000	+150.0
Iraq	25,000	28,000	28,800	26,300	95,000	+70,000	+280.0
Kuwait	33,000	31,500	29,900	36,400	48,600	+15,600	+47.3
Qatar	8,000	40,000	62,000	156,700	163,100	+155,100	+1,938.8
Saudi Arabia	50,000	85,000	117,000	139,900	181,347	+131,347	+262.7
Others	16,150	15,160	30,170	51,830	55,203	+39,053	+241.8
Total Middle East	**344,150**	**719,660**	**769,730**	**1,084,030**	**1,226,150**	**+882,000**	**+256.3**
Algeria	105,000	125,000	111,250	105,900	114,000	+9,000	+8.6
Libya	27,500	25,700	21,500	25,700	25,500	−2,000	−7.3
Nigeria	40,000	43,000	32,400	84,000	87,400	+47,400	+118.5
Others	16,515	13,804	24,273	33,030	39,830	+23,315	+141.2
Total Africa	**189,015**	**207,504**	**189,423**	**248,630**	**266,730**	**+77,715**	**+41.1**
Argentina	8,800	8,120	25,200	23,600	27,299	+18,499	+210.2
Mexico	11,500	30,000	75,850	76,530	73,380	+61,880	+538.1
Trinidad & Tobago	7,500	8,500	11,000	10,390	9,968	+2,468	+32.9
Venezuela	34,600	41,000	54,079	95,000	100,846	+66,246	+191.5
United States	271,455	210,000	204,000	186,700	165,000	−106,455	−39.2
Canada	55,000	58,000	97,000	98,000	94,300	+39,300	+71.5
Others	16,818	20,960	20,462	21,140	22,201	+5,383	+32.0
Total Western Hemisphere	**405,673**	**376,580**	**487,591**	**511,360**	**492,994**	**+87,321**	**+21.5**
Total Non-Communist	**1,218,474**	**1,564,659**	**1,749,727**	**2,287,000**	**2,425,819**	**+1,207,345**	**+99.1**
U.S.S.R.	635,400	920,000	1,240,000	1,450,000	1,500,000	+864,600	+136.1
Others	29,000	35,000	43,800	60,000	63,300	+34,300	+118.3
Total Communist	**664,400**	**955,000**	**1,283,800**	**1,510,000**	**1,563,300**	**+898,900**	**+135.3**
Total World	**1,882,874**	**2,519,659**	**3,023,527**	**3,797,000**	**3,989,119**	**+2,106,245**	**+111.9**
Total OPEC	**561,600**	**980,150**	**1,018,564**	**1,452,720**	**1,620,158**	**+1,058,558**	**+188.5**
OPEC as % of World	29.8%	38.9%	33.7%	38.3%	40.6%	—	—

*Includes Brunei

Source: Oil & Gas Journal

were 56% higher than they were 10 years earlier at the start of 1980. Non-communist reserves as of the first of 1990 were 917.4 billion barrels. This is up 66.3% from 1980. OPEC reserves at the first of 1990 were 767 billion barrels, which is 76.6% of total world reserves and 83.6% of total non-communist reserves.

The reserves/production ratio was 35.2 years in 1975. This fell to 26.7 years in 1979, the year of peak worldwide production. In 1984, the ratio moved up to 31.7 years. With the huge upward revisions in reserves, this increased to an estimated 42.7 years in 1988, 42.9 years in 1989, and 46 years in 1990.

Worldwide reserves have been replaced and even increased throughout the past 10 years. This was mainly due to the increased value of oil that stimulated increased exploration activity. The reserves/production ratio has been maintained and there is no apparent immediate pressure on oil

availability. However, investment in exploration and production activity will have to be sustained if the reserves/production ratio is to be maintained at this level.

It is evident from the reserves profile that OPEC still holds the key position in future world supply. And unless activity is sustained in the non-OPEC areas, the OPEC dominance over production and prices will be reestablished in the near future. It is evident that in the long run OPEC holds the reserve position to dominate the world oil industry.

REFINING. Another key element of the supply side of the equation is refining. The worldwide refining industry has gone through a cycle somewhat similar to that of production. That cycle has also been brought on by the volatile change in prices.

With the drop in demand for petroleum products, crude runs in refineries also fell sharply. As refinery runs fell, excess capacity developed in the refining industry. Refining capacity represents a substantial fixed investment in plant and equipment. Therefore, adjustment of capacity to the declining demand was a slow process.

There was an initial delay in reducing refining capacity as refineries attempted to determine if the peaking of demand, and subsequent decline, was a temporary phenomenon, or to determine if it was a permanent demand adjustment that would require adjustment in refining capacity. Based on the long-term forecasts available at that time, which projected steadily increasing long-term demand, refineries initially adjusted by running at a lower utilization rate. As it became apparent that the downturn in demand was signaling a much lower long-run level of demand, refineries realized that the industry was faced with a massive excess capacity.

Confronted with sharply reduced, and in many cases, negative refining margins, refiners started to adjust capacity by mothballing or permanently closing facilities. Non-communist refining capacity peaked in 1980 at 65.7 million b/d and remained relatively high in 1981 at 65.14 million b/d. After those years of research, capacity was reduced at a more rapid rate and fell to 56.135 million b/d in 1986. Capacity fell again in 1987 to 55.75 million b/d and was down 9.95 million b/d, 15.1%, from the peak in 1980.

However, 1988 seems to have been a turning point in the cycle. Demand for petroleum products has been on the rise in recent years. In response, non-communist refining capacity moved up to 56.550 million b/d in 1988, stopping the seven-year slide. Increased demand led to additional capacity being added in the U.S. There were also net capacity additions in the Middle East and Africa. These additions more than offset reductions elsewhere.

The slide in refining capacity continued in 1989 with a 1.1% drop to 55.9 million b/d. U.S. and Canadian capacity was reduced again. Capacity in Western Europe and the Middle East also declined. This was partially offset by increases in Latin America, Africa and the Far East.

Refining capacity in the communist areas and former communist areas of China, U.S.S.R., and Eastern Europe has been moving up steadily. Capacity in the U.S.S.R. increased to 12.3 million b/d in 1989. Capacity in East Europe moved up 7.3% in 1989 to 3.42 million b/d. And refining capacity in China climbed 5.5% in 1989 to 2.47 million b/d.

The reduction in demand for petroleum products in the early 1980s led to a drop in refinery throughput. And this resulted in a sharp drop in the refinery utilization rate. The refinery utilization rate for non-communist world refineries fell to 65.4% in 1982, from 74.3% in 1978. A lower utilization rate increases the unit cost of refined products and reduces refining margins. This was a great incentive to adjust refining capacity in an attempt to increase profitability.

A cut in crude refining capacity, and an increase in demand, boosted the rate to 75.3% in 1986. It moved up to 76% in 1987 due to the

VALUE—OPEC PETROLEUM EXPORTS

Year	Crude exports	Product exports (1,000 b/d)	Total exports	Value of exports ($ million)	Average value ($/bbl)
1980	22,866.7	2,011.1	24,877.8	284,503	31.33
1981	18,549.9	1,980.6	20,530.5	263,243	35.13
1982	14,269.8	2,226.4	16,496.2	202,776	33.68
1983	12,473.4	2,022.8	14,496.2	157,134	29.70
1984	12,023.4	2,281.8	14,305.2	143,663	27.51
1985	10,805.1	2,410.2	13,215.3	127,181	26.37
1986	12,830.2	2,673.7	15,503.9	77,314	13.66
1987	11,965.7	2,925.3	14,891.0	93,042	17.12
1988	13,576.9	3,186.2	16,763.1	86,364	14.12
Average	**14,373.5**	**2,413.1**	**16,786.6**	**159,469**	**26.03**

Source: OPEC Statistical Bulletin

NET BACK PRICING EXAMPLE

	$/barrel
Product revenues	18.50
Less: refining costs	2.50
Less: processing handling fee	2.00
Less: transport cost	1.50
Net back price of crude*	**12.50**

*The net back value varies depending on product revenues and costs

increase in throughput and decline in capacity. This increased to 77.3% in 1988 as the 2.9% increase in throughput surpassed the 1% increase in capacity. The capacity utilization rate moved up again in 1989 to 80% as capacity declined and crude runs increased.

The utilization rate in the U.S.S.R. and East Europe is at about the same level, 78.7% in 1989. This is down from 80.8% in 1989. In these areas, crude runs fell while capacity increased.

The improvement in the utilization rate over the last several years was primarily due to the reduction in capacity. But in the last four years, 1986 through 1989, increased throughput due to the improvement in demand has made a major contribution to the improvement in the utilization rate.

This improvement in refining utilization has improved profitability in the refining sector of the industry. However, there is now emerging another threat to refining profitability, and that is the increase in OPEC refining capacity. It appears apparent that some of the OPEC countries intend to carve out a

portion of the refined products market. OPEC has plans to increase their refining capacity substantially. Plans are now being reviewed to attempt to boost capacity to 8.5 million b/d. OPEC countries will not only be supplying a much greater percentage of their own internal petroleum product requirements, but will also be expanding their role in the product export market.

OPEC refining capacity was 6.538 million b/d in 1988, up 27.3% from 1982. As consumption grows in the OPEC countries, it is likely that refining capacity will increase. And it is probable that additional capacity will be added to supply products for export.

This may really be one of the major issues of concern to the world oil industry in the future. The major international oil companies have lost control over a substantial portion of world crude production. Now they will be meeting competition from OPEC in refining. This is probably also of concern to the major industrial countries. A great deal of revenue is derived from taxes on refined products. If OPEC is able to capture a portion of the refined product market, they may capture the revenue now collected as taxes by the industrial countries, or substantially drive up the prices of refined products.

Several of the major OPEC oil-producing countries have also adopted a new strategy. Venezuela, Kuwait and Saudi Arabia have made substantial investments in downstream refining and marketing facilities in the industrial countries. They appear to be trying to establish major fully integrated operations in these areas, similar to the major international oil companies. They are seeking secure markets for their crude and also trying to capture some of the profit from these downstream activities.

Refiners also play a major role in the maintenance of crude and petroleum product stock

levels. And stock levels play a major role in determining short-run and seasonal swings in crude demand and prices.

When the turnaround started, in 1980 and 1981, the reluctance of refiners to adjust immediately to the initial drop in demand, coupled with a reluctance to break long-term contractual agreements for crude from export nations, resulted in a huge buildup of stocks. Stocks for the OECD group of countries increased 465 million bbl from year end 1978 to year end 1980, and peaked at 3,587 million bbl at year end 1980.

Refiners originally defended the high stock levels as a buffer against a potential supply disruption and a rebound in demand. But the acceleration in worldwide inflation brought high interest rates that translated into very high carrying costs for the excessive inventories. With depressed margins and sharply reduced profits, it was essential that action be taken to reduce these costs.

Refiners found it difficult to reduce stocks in the face of falling demand, but they made a concentrated effort by breaking long-term crude supply agreements. This in effect forced stocks back into the ground by reducing offtakes from the producing countries. From 1980 to 1985, stocks of the OECD countries were reduced 301 million bbl. These were all private stocks in the hands of refiners, and marketers. Public/government stocks such as the U.S. Strategic Petroleum Reserve continued to be increased, however. Those stocks represent a government-financed buffer to protect against supply disruptions.

With increased demand and the continued buildup in government stocks, total stocks moved up in 1986 and 1987. Stocks remained at about the same level in 1988 and 1989. Part of this buildup is also due to the lower crude prices. It is not as costly at present for refiners to hold stocks as a contingency. But refiners have developed an efficient system and are able to operate with a much lower stock level than in previous years. It now appears that refiners have reached an acceptable balance between demand and stocks and therefore have stopped their inventory drawdown. And with demand on the rise, refiners are adding to stocks to maintain this balance. Refiners have to keep a minimum level of stocks in order to operate efficiently.

Sharp fluctuations in price can cause refiners to moderate this operating philosophy. When prices drop, they generally build inventories to take advantage of the low-cost crude. And if prices move up rapidly, there is a tendency for refiners to reduce inventories and minimize costs.

NATURAL GAS. Oil is only one of several major energy sources. This must be taken into consideration when analyzing the need for oil. Over the past 10 years, the level of worldwide oil production has been influenced primarily by the price of oil, butcompetition from competing fuels has also been a factor.

One of the major competing fuels has been natural gas. And natural gas is growing in importance as a fuel throughout the world.

Total world production in 1989 was 67.4 trillion cubic feet. This was up 3.2% from 1988 and up 32.4% from 1979. Non-communist area production was 40.2 trillion cu. ft. in 1989. This was up 12.4% from 1979. The communist countries posted the greatest increase over the 10 years 1979–89. Production was up 79%, to 27.3 trillion cu. ft. in 1989. All of the increased production was in the U.S.S.R. with 1989 production of 25.3 trillion cu. ft. up 12.1 trillion cubic feet, 82.3%, over the 10 years. The U.S.S.R. passed the U.S. in 1983 to become the world's largest natural gas-producing country.

All of this production is not consumed in the U.S.S.R. or in Eastern Europe. The U.S.S.R. has recently been exporting large volumes of gas to Western Europe. They have been concentrating a lot of resources on developing natural gas. In addition to exports, they have adopted a policy of transforming segments of their economy from oil-consuming to natural gas. This enables them to

export greater volumes of crude oil, and obtain hard currency for foreign trade. Their plentiful reserves enable them to pursue both of these objectives.

World trade movements of natural gas totaled 7.8 trillion cu. ft. in 1989. Exports from the U.S.S.R. accounted for 45.1% of this volume, totaling 3531 billion cu. ft. Exports from Canada to the U.S. were 17.1% of the total, at 1,338 billion cu. ft. The Netherlands exported 1,197 billion cu. ft. and Norway exported 1,010 billion cu. ft.

North America and Western Europe were the only major geographic area where natural gas production was lower in 1989 than in 1979. North American production was down 8.7% over this period. The decline was due to a 12.7% reduction in U.S. output. Canadian production was up 17.4% over 1979.

Production in Western Europe was down 2.9% from 10 years earlier, primarily due to a drop in Netherlands output. In other major areas, production was up; +74.6% in Africa, +129.9% in Asia and Australasia, +57.6% in Latin America, and +47.2% in the Middle East.

The natural gas share of worldwide total primary energy consumption moved up from 18.2% in 1975 to 20.1% in 1985. It fell slightly to 19.9% in 1986, then moved up to 20% in 1987, 20.2% in 1988 and 21.3% in 1989. In the non-communist countries, natural gas lost some of its market share, dropping from 19.2% in 1975 to 18.9% in 1985 and 18.1% in 1986. This was primarily due to a drop in U.S. natural gas production and consumption. In 1987, the market share moved up to 18.8%. It remained at 18.3% in 1988 but increased to 19.5% in 1989. In 1989, total consumption increased another 3.2%. It was up in all areas.

Although there has been no dramatic shift to natural gas, there have been some indications that demand may increase sharply in the future. It is a clean-burning fuel that does not pollute and is therefore looked upon favorably by those concerned with the environment. And concern for the environment is growing throughout the world.

The biggest hurdle to jump, if consumption is going to rise, is the high cost of transporting natural gas from the areas with large reserves to the industrial consuming areas. Natural gas is most efficiently transported by pipelines, but long pipelines are very expensive. It can be liquefied and shipped by tanker, but this is also extremely expensive.

As with oil, natural gas reserves are distributed disproportionately, with reserves concentrated in a few countries. The U.S.S.R. has by far the largest reserves, with 1,500 trillion cu. ft., 37.6% of the world total, as of January 1, 1990. At their present rate of production, they have a 53.3 year supply.

Iran has the second largest level of reserves, with 500 trillion cu. ft., 12.5% of total world reserves. Together, Iran and the U.S.S.R. have over 50% of total world reserves.

At the present time, non-communist reserves are about 2,426 trillion cu. ft. This includes the Iranian reserves. At the 1989 rate of production, this represents a 56.1 year supply. But a substantial proportion of those reserves are in countries far from the areas of consumption. This will make it very expensive to utilize these reserves.

U.S. reserves are only 4.1% of the total world reserves and only 6.8% of non-communist reserves. And the reserves to production ratio indicates only a 9.2 year supply at the 1989 rate of production.

OUTLOOK

The invasion of Kuwait by neighboring Iraq in early August 1990 has had a substantial impact on the demand-supply relationship in the worldwide petroleum industry. These two countries together were producing around 4.7 million b/d at the time of the invasion. The subse-

quent embargo of crude oil from Iraq and Kuwait removed close to 4.2 million b/d in exports from these two countries. In addition, 300,000 b/d of production from the Kuwaiti share of the Neutral Zone was also affected by these events.

The sharp reduction in worldwide crude oil supply had an almost immediate impact on crude oil prices. Prices were on the rise before the invasion, but moved up sharply after. The average price of world export crude oils increased 50% in the three weeks following the invasion. Prices on the futures market moved up over $30/bbl and hit the highest level since 1985.

There is no way to determine if the sharp rise in prices has had an immediate impact on demand for petroleum products. However, it is fairly safe to assume that an increase in oil prices of that magnitude will have a substantial impact on demand for petroleum products, if it lasts for an extended period. And if the demand for petroleum products declines, the demand for crude oil will follow. But the impact will go beyond the demand for petroleum products. If oil prices remain higher for an extended period, other energy costs will begin to move up as fuel substitution increases the demand for other fuels. The resulting increase in energy costs will have an impact on economic growth.

At this time it is uncertain how long the crisis involving Iraq and Kuwait will last. It is quite probable that the loss of this volume of crude oil will exert upward pressure on crude oil prices as long as the crisis continues. This makes it almost impossible to project with any certainty the most likely trend in economic growth, energy demand, demand for petroleum products and production of crude oil.

Therefore, for the first time in this edition of the Oil Industry Outlook, three scenarios are being presented. The three scenarios vary in expectations of the length of time the crisis in the Persian Gulf will last. The length of time the oil crisis continues will have an impact on the price of crude oil, the cost of energy, the rate of economic growth, the level of energy consumption, the level of petroleum product demand and the demand for crude oil. To cover these variations three separate forecasts are presented. The forecast with the highest degree of probability is the one where the basic assumption comes closest to the actual length of time it takes to finally resolve this issue in the Middle East, and for Iraqi and Kuwaiti oil to return to the market.

SCENARIO I—The situation in the Middle East lasts for an extended period. The embargo of oil exported from Iraq and Kuwait continues for a period of 6–18 months. The vast majority of oil production in Iraq and Kuwait is shut in for the duration of the dispute. Production and exports from the Kuwaiti half of the Neutral Zone are also curtailed during this period. Oil production capacity in other OPEC areas is not affected by the dispute. Following the settlement of the dispute, production in Iraq and Kuwait is resumed at levels close to the production levels prior to the invasion.

SCENARIO II—The situation in the Middle East lasts for an even longer time period than in Scenario I. The embargo of oil exported from Iraq and Kuwait continues for a period of 18–30 months. The vast majority of oil production in Iraq and Kuwait is shut in for the extended duration of the dispute. Production and exports from the Kuwaiti half of the Neutral Zone are also curtailed during this period. Oil production capacity in other OPEC areas is not affected by the dispute. Following the settlement of the dispute, production in Iraq and Kuwait is resumed at levels close to the production levels prior to the invasion.

SCENARIO III—The situation in the Middle East lasts for a relatively short period of time. The embargo of oil exported from Iraq and Kuwait continues for less than six months. The vast majority of oil production in Iraq and Kuwait is shut in during this period. Production and exports from the Kuwaiti half of the Neutral Zone are also curtailed during this short period. Production capacity in other OPEC countries is not affected by this dispute. Following settlement of the dispute, produc-

tion in Iraq and Kuwait is resumed at production levels close to those prior to the invasion.

The major differences between the three scenarios is the length of time that the crisis continues and Iraqi and Kuwaiti oil is off the market. But even though the length of time until settlement of the dispute is the only apparent difference, these three scenarios will cause three distinct sets of conditions in the oil market. And the different market conditions will create differing projections of demand for energy, demand for petroleum products, and worldwide supply of crude oil over the forecast period, 1991–95.

The disruption of oil production and oil exports from Iraq and Kuwait will have an immediate impact on crude oil and petroleum product prices. And it is expected that the loss of this oil will tighten the market and place upward pressure on prices while the crisis lasts. Prices will fluctuate with seasonal demand because requirements for OPEC oil will come close to capacity during the periods of peak demand. As demand approaches capacity, prices will be bid up by refiners and traders looking for supplies to meet winter demand.

With the elimination of supplies from Iraq and Kuwait, a substantial portion of the OPEC excess capacity has been eliminated. Therefore as long as that production remains shut in, the crude oil market will be tight, with little contingency production capacity available. Prices will remain much higher than they would be if this capacity was available to the market.

Politics, the price level, the rate of economic growth, demand for petroleum products and the OPEC level of production will all play a role in determining the outlook on the supply side of the worldwide oil industry. As stated, the price level will be greatly influenced by the length of the conflict between Iraq and Kuwait. But the price level will also be greatly influenced by the level of OPEC production. This will be before and after the settlement of the dispute. And the OPEC production level will in turn be influenced by OPEC politics and individual OPEC country economics.

OPEC will have one of the greatest influences but there are other factors that will also dictate the supply side of the industry outlook. The total supply of crude that is made available in the non-OPEC areas will be determined primarily by the price level. But in the non-OPEC areas there are other factors that are now exerting a great deal of influence. The natural decline rate is beginning to take hold in some of the major non-OPEC producing areas. The Alaskan North Slope and some of the North Sea fields are prime examples of fields with peaking production and expectations of long-run future decline.

The outlook for worldwide supply was altered dramatically when prices dropped sharply in 1986. The cyclical fluctuation of prices and the repeated weakness in prices over the past several years have reduced investment in production. Both the level of production and the geographic pattern of supply have been altered by the repeated price corrections. Even though prices rebounded in 1987 and 1989, they did not return to the pre-1986 levels. With prices slipping repeatedly, the industry is caught in an era of frequent periods of lower than anticipated crude prices. This is expected to be the probable pattern after the dispute is settled.

During the last few years, the level of production has been oscillating with the level of prices. Production moved up in 1986 with the precipitous drop in prices. Output slipped in 1987 when prices rebounded, and then production moved up again in 1988 as prices slipped. The relatively low level of prices since 1986 has helped stimulate demand for petroleum products. This helped boost output in 1989, even though prices were up from the previous year. The rebound in prices in 1989 was more gradual and the price hike was not as great as in 1987.

The huge overhanging excess capacity continues to exert substantial downward economic pressure on prices. The only way that this pressure can be counteracted in the short run is by shutting in substantial production capacity. If sufficient

capacity was shut in, the pressure on prices could be reversed and crude prices could be raised and/or supported at a higher level. The invasion has accomplished this by shutting in a substantial volume of production and tightening the market.

Other than through armed conflict, the only producing entity that has the ability to curtail sufficient capacity to influence the price level is OPEC. So when the dispute is settled, the price level over the remainder of the forecast period will be almost solely dependent upon OPEC's willingness to rein in production. And that is dependent upon the political/economic situation in the individual OPEC countries.

Upward pressure on prices could also emerge if there were a substantial increase in demand. This would also reduce the excess capacity. But in the highly competitive energy market, a large increase in demand can only be achieved at relatively low prices: competitive prices that would prevent switching to alternative fuels such as natural gas or coal. Economic growth is generally relatively modest so that any large increase in demand will only be realized over an extended period of time.

Therefore, any immediate extended increase in prices in a time of peace can be achieved only if OPEC establishes and adheres to a quota that comes close to balancing supply and demand.

SCENARIO I—under this scenario, prices will remain inflated during the next 6 to 18 months until the dispute is settled in the Middle East. Prices have already increased substantially and it is estimated that the average price of world export crude will be up 20% in 1990 at an average of $20/bbl for the year. With the tight supply situation, prices will increase another 25% in 1991 to an average of $25/bbl. It is assumed under this scenario that the Iraq-Kuwait dispute will be settled around the first part of 1991 and this oil will be returned to the market. There will be a return to a situation of excess OPEC capacity which will result in downward pressure on prices. The average price for world export crudes will fall 22% to $19.50/bbl in 1991. For the remainder of the forecast period 1992–95, prices will move up gradually due to increased demand. The average price will increase to $22.50/bbl in 1995. Prices will not return to the level reached under the shortage conditions that prevailed in 1991.

SCENARIO II—under this scenario, oil prices will remain inflated for an extended period of 18 to 30 months. Crude prices will move up to $25/bbl in 1991 as in Scenario I. With the Iraq-Kuwait production still shut in during 1992, prices will continue to move up, averaging $27.50/bbl for that year. It is assumed that the conflict will be resolved around the end of 1992 or early 1993 and that the production and exports from Iraq and Kuwait will re-enter the market. This additional capacity will result in excess capacity in 1993 and downward pressure on prices. The average price of world export crude will drop sharply, down 31% to $19/bbl. There will be additional downward pressure under this scenario. Lower demand due to high product prices in 1991 and 1992 will have an impact on the market clearing prices.

Coupled with this, there will be additional capacity developed during the high-prices years to help make up for the shortage, which also will contribute to the downward pressure on prices. Prices will move up gradually during the remainder of the forecast period 1994–95, reaching $22/bbl in 1995. Prices at the end of the forecast period will end up lower than under Scenario I because of slower economic growth, lower petroleum product demand and additional crude production capacity.

SCENARIO III—under this scenario, the dispute in the Middle East will be resolved by the end of 1990 or early 1991. The lost production and exports from Kuwait will have an impact on the market in the latter half of 1990, but not in the years following. Prices will move up in 1990 and average $19.50/bbl, an increase of 17%. However after the shut-in production is returned to the market, prices will fall back to the expected longer-

term trend and average $18/bbl in 1991. The OPEC excess capacity will again have a moderating impact on prices. Over the remainder of the forecast period, crude prices will continue to move up and will average $23/bbl in 1995. Increased demand and a reduction of the excess capacity will put moderate upward pressure on prices.

It is expected that OPEC will continue to be a major factor in determining the worldwide prices for crude oil and therefore the worldwide demand for petroleum products once this dispute is settled. It is also expected that the OPEC countries with the largest reserves will have the most influence in setting OPEC target prices. OPEC's policy again will be to establish a market clearing production level that will result in a targeted price for their exported crude oil.

In the past, OPEC's inability or unwillingness to keep its production in line with the selected quota and product demand was the major reason for the volatility in prices. And price volatility had an impact on product demand. This problem may continue to plague OPEC and the oil market, but it is expected that there will be more production discipline after the end to the Iraq-Kuwait crisis. After the crisis is settled, the situation will return to one in which there is excess production capacity. This should help keep prices relatively low. And the lower prices should stimulate product demand.

It is expected that inflation will average in the range of 3–4%/year over the forecast period. The modest rise in crude oil prices will mean that the real price of crude will remain fairly constant and may even decline once the Middle East crisis is resolved. This would be very stimulative to petroleum product demand. However, this is consistent with one of the key objectives of the OPEC countries with large reserves.

It is expected that in the years after the dispute is settled, years with a relatively low price level, demand will be stimulated. But this in turn will generate a modest amount of upward economic pressure. And it is also expected that OPEC periodically will show some level of discipline, curtailing production from time to time. This will put some additional upward pressure on prices. Therefore even after the dispute is settled there will be a slow steady increase in crude oil prices.

SCENARIO I—The high oil prices during the first year of the forecast period will dampen demand in 1991. Most of the lost oil from Iraq and Kuwait will be made up by increased production from the other OPEC countries with excess capacity. Total world demand /production of crude oil will move up only 1% in 1991 to 64.875 million b/d. After prices decline in 1992, demand and production will increase at a faster rate. World production will move up 2.45% in 1992, to 65.78 million b/d. Production will move up steadily for the remainder of the forecast period mainly due to the relatively low level of oil prices. World production over the five-year forecast period will move up 7%, to 68.69 million b/d in 1995, an increase of 4.48 million b/d. The vast majority of the increase will come from OPEC production. OPEC production will increase 16.2% over the forecast period, to 28.08 million b/d in 1995, an increase of 3.905 million b/d. The increase in OPEC production will account for 87% of the total increase in world output.

SCENARIO II—Under this scenario, oil prices will remain high throughout 1991 and 1992. Average prices will continue to climb in 1992 due to periodic seasonal shortages of crude oil. This will dampen demand for these two years of the forecast period. Most of the lost crude will be made up by the other OPEC countries with excess capacity. Production is expected to increase 2.2% by 1992. After the prices fall in 1993, demand and production will increase at a faster rate. Production over the last four years of the forecast period will move up another 4.4%. Over the forecast period, production will increase 6.7%, reaching 68.51 million b/d in 1995. This is an increase of 4.3 million b/d. Non-OPEC production is expected to move up

more than under Scenario I, due to the high level of prices for a longer period of time. Non-OPEC production will increase 3.4%, to 25.6 million b/d. OPEC will supply most of the increase in worldwide production over the forecast period. OPEC production will move up 13.3%, to 27.4 million b/d in 1995, an increase of 3.225 million b/d. OPEC will account for 75% of the increase in worldwide production.

SCENARIO III—Under this scenario, prices will remain inflated for a short period of time, less than 6 months. This will have a dampening effect on petroleum demand only for the early part of 1991. Prices will fall in 1991 after the dispute is settled and Iraqi and Kuwaiti oil returns to the market. There will be a potential oil shortage only in the winter of 1990/1991. The extent of the shortage will depend on how much of the lost oil is replaced by increased production from other OPEC countries with excess capacity. It will also depend on the level of winter demand. Over the forecast period, worldwide oil production will move up 8.3%, to 70.27 million b/d in 1995, an increase of 5.365 million b/d. Increased oil production in OPEC will account for 94% of the increase. With no extended period of higher oil prices, there will be little increase in non-OPEC production. OPEC output will move up 20.3%, to 29.93 million b/d in 1995, an increase of 5.06 million b/d.

Under all three scenarios by the end of the forecast period, OPEC production will have increased substantially and reduced the excess capacity. This will be the case particularly in Scenario III where OPEC output will move up to almost 30 million b/d. In any case, OPEC will be in a position at the end of the forecast period which might enable the group to boost prices substantially. By that time OPEC output will have climbed to a range from 40% of total world output in Scenario II to 42.3% in Scenario III. OPEC's share of non-communist output will have climbed to a range from 51.7% in Scenario II to 54.6% in Scenario III.

At that time the price level will be more dependent upon the objectives of Saudi Arabia and the group of OPEC countries with huge reserves. If this group of OPEC countries decides to meet the rising demand by increasing output and capacity, they can maintain control over prices. With their substantial reserves it would appear to be in this group's best interests to keep price increases modest and prevent prices from increasing rapidly. It would appear to be in their long-range best interests to keep prices at a level that will stimulate demand and discourage investment in competing oil and energy sources.

Once the Iraq-Kuwait dispute is settled and their oil production is back on the market, the lower level of prices is expected to stimulate demand for petroleum production, and therefore crude oil production, throughout the remainder of the forecast period. Current dollar prices are not expected to get back up to the pre-1986 level after the resolution of the dispute. Real prices are not expected to move up substantially and they will be much lower than the 1979–85 period.

The exploration effort is expected to follow crude oil prices throughout the forecast period. The active international rig count (outside the U.S. and Canada) continued to fall in 1989, dropping to an average of 922 active rigs for the year. As prices move up and demand for oil moves up over the forecast period, the rig count is projected to increase. With the sharp increase in prices in the early years in Scenarios I and II, the rig count is forecast to move up sharply for a short period. When prices drop the rig count is expected to fall, but not to the low level of 1989. Under all of the scenarios the international rig count is expected to increase to around 1,025 active rigs in 1995.

Refining capacity in the world is sufficient to handle the expected increase in demand, but a modest increase is expected as demand moves up. A higher utilization rate is more profitable for the industry, so capacity will not move up as fast as demand. Total worldwide refining

capacity is expected to move up marginally over the forecast period. Total capacity is expected to increase from 1.5% in Scenario II to 3.6% in Scenario III. Total capacity by year 1995 will range from 75.8 to 77.4 million b/d.

In the industrial countries, refining capacity is still being adjusted to the lower level of petroleum product demand that was a result of the price shocks. Refining profitability is substantially affected by the utilization rate. Refiners strive for a utilization rate of over 80% in order to achieve adequate margins.

Although capacity will remain relatively constant over the forecast period, crude runs to refineries will move up with demand. Crude runs will increase from 6.7% in Scenario II to 8.2% in Scenario III. Crude runs in 1995 will range from 64.46 million b/d to 65.76 million b/d. As a result, the overall average utilization rate will move up steadily. The utilization rate will increase from 80% in 1989 to 85% in 1995.

There is a possibility that some industrial countries may consider an adequate level of refining capacity as a national security objective. If that proves to be the case, there may be some additional increase in refining capacity over the forecast period. But it is doubtful that there will be a significant additional increase.

There is not expected to be any major geographical shift in natural gas production over the forecast period. The U.S.S.R. is expected to continue to develop their vast reserves, and they are expected to continue to supply European energy needs.

Natural gas resource development is expected to continue to expand over the 1991–95 period. But the area with the largest reserves, the Middle East, is politically unsettled and a long distance from the larger consuming areas. Therefore, any increase in reserves or output in this area is not expected to have a major impact on world energy needs. However, increased natural gas development for internal consumption in this area would release additional crude for export. That would reduce the upward pressure on prices resulting from increased crude oil demand.

WORLDWIDE SUPPLY KEYS TO THE FUTURE

SCENARIO I

1. During the first year of the forecast period, 1991, there will be a very tight oil market. The dispute between Iraq and Kuwait is expected to last for 6 to 18 months. The embargo on oil from these two countries is expected to continue throughout this entire period. Crude shortages may be experienced during the periods of high seasonal demand. Prices will remain high through 1991. During the period of high prices, the growth in petroleum product demand will be reduced. This will mean a slower growth in crude production.

2. It is expected that the dispute will be settled by the end of 1991. Production from Iraq and Kuwait will return to the market in 1992 and crude prices will fall in 1992. This should stimulate demand and result in a somewhat highe growth rate for world crude production.

3. The return of Iraqi and Kuwaiti oil will mean a return of excess production capacity which will put downward pressure on prices throughout the remainder of the forecast period. Coupled with some possible lapses in OPEC production discipline, this will keep crude prices well below the 1980–85 levels throughout the latter years of the forecast period.

4. After the dispute is settled and prices fall, relatively low prices and economic growth will stimulate demand for petroleum products and crude oil throughout the remainder of the forecast period. Worldwide production will move up along with demand.

5. It is expected that OPEC will continue to be an effective cartel after this dispute has been resolved. Therefore in the years 1992–95 OPEC's ability to set a realistic production quota and adhere to it will again play a major role in determining the price level. Control of OPEC will be dominated by the group of OPEC countries with huge reserves. This group will be led by Saudi Arabia, and it is expected that OPEC will show some discipline and have periodic success in supporting the desired price level.

6. Non-OPEC production will be stimulated by the jump in prices in 1991. The perceived vulnerability of oil supply may also stimulate some additional exploration activity. Therefore non-OPEC output is expected to move up early in the forecast period. However, production will begin to slide during the latter years of the forecast period. Several major producin areas will peak and begin a natural decline.

7. OPEC output will move up to fill the gap between increasing demand and falling non-OPEC output. OPEC's share of total world production will increase. By the end of the forecast period, OPEC production will be up to 28.08 million b/d, 40.9% of world production and 52.8% of production outside of the Centrally Planned Economies. With increased production some of the OPEC excess capacity will be reduced. This will allow a gradual increase in prices.

8. Refining capacity will be increased marginally as demand moves up. Crude throughput will move up along with demand. The refinery utilization rate will increase throughout the forecast period.

THE OUTLOOK — WORLDWIDE SUPPLY
SCENARIO — I

	1989	1990	1991	1992	1993	1994	1995	Change 1990 to 1995	% change 1990 to 1995
WORLD OIL PRODUCTION									
Total liquids									
(thousand barrels/day)									
OPEC	23,215	24,175	24,460	25,020	26,020	27,060	28,080	+3,905	+16.2
Non-OPEC	24,670	24,765	25,105	25,400	25,300	25,200	25,100	+335	+ 1.4
Total Non CPE's	**47,885**	**48,940**	**49,565**	**50,420**	**51,320**	**52,260**	**53,180**	**+4,240**	**+ 8.7**
Centrally Planned Economies									
(CPE's)	15,675	15,270	15,310	15,360	15,410	15,460	15,510	+ 240	+ 1.6
Total World	**63,560**	**64,210**	**64,875**	**65,780**	**66,780**	**67,720**	**68,690**	**+4,480**	**+ 7.0**
WORLD REFINING									
(thousand barrels/day)									
Capacity	74,400	74,700	74,950	75,200	75,500	75,750	76,000	+1,300	+ 1.7
Crude runs	59,495	60,415	61,040	61,890	62,830	73,710	64,620	+4,205	+ 7.0
Utilization rate (%)	80.0	80.9	81.4	82.2	83.2	84.1	85.0	+4.1	+ 5.1
World active drilling rigs									
(Excluding USSR & East Europe)									
Outside U.S. & Canada	922	940	1,010	970	990	1,015	1,025	+ 85	+ 9.0
Canada	130	135	175	150	160	175	185	+50	+37.0
U.S.	869	1,010	1,175	1,085	1,145	1,210	1,275	+265	+26.2
Total	**1,921**	**2,085**	**2,360**	**2,205**	**2,295**	**2,400**	**2,485**	**+400**	**+19.2**
Crude oil price									
Average world export price ($/barrel)	16.65	20.00	25.00	19.50	20.50	21.50	22.50	+2.50	+12.5

WORLDWIDE SUPPLY KEYS TO THE FUTURE SCENARIO II

1. During the first two years of the forecast period, 1991 and 1992, there will be a very tight oil market. The dispute between Iraq and Kuwait is expected to last for 18 to 30 months. The embargo on oil from these two countries is expected to continue throughout this entire period. Crude shortages may be experienced during periods of high seasonal demand. Prices will remain high through 1991 and move even higher in 1992. During the period of high prices, the growth in petroleum product demand will be reduced. This will mean a slower growth in crude production.

2. It is expected that the dispute will be settled by the end of 1992. Production from Iraq and Kuwait will return to the market in 1993 and crude prices will fall in 1993. This should stimulate demand and result in a somewhat higher growth rate for world crude production.

3. The return of Iraqi and Kuwaiti oil will mean a return of excess production capacity which will put downward pressure on prices throughout the remainder of the forecast period. Coupled with some possible lapses in OPEC production discipline, this will keep crude prices well below the 1980–85 levels throughout the latter three years of the forecast period.

4 After the dispute is settled and prices fall, relatively low prices and economic growth will stimulate demand for petroleum products and crude oil throughout the remainder of the forecast period. Worldwide production will move up along with demand.

5. It is expected that OPEC will continue to be an effective cartel after this dispute has been resolved. Therefore in the years 1993–94 OPEC's ability to set a realistic production quota and adhere to it will again play a major role in determining the price level. Control of OPEC will be dominated by the group of OPEC countries with huge reserves. This group will be led by Saudi Arabia and it is expected that OPEC will show some discipline and have periodic success in supporting the desired price level.

6. Non-OPEC production will be stimulated by the jump in prices in 1991 and 1992. The perceived vulnerability of oil supply may also stimulate some additional exploration activity. Therefore non-OPEC output is expected to move up in the earlier years of the forecast period. However, production will begin to slide during the latter years of the forecast period. Several major producing areas will peak and begin a natural decline.

7. OPEC output will move up to fill the gap between increasing demand and falling non-OPEC output. OPEC's share of total world production will increase. By the end of the forecast period, OPEC production will be up to 27.4 million b/d, 40% of world production and 51.7% of production outside of the Centrally Planned Economies. With increased production some of the OPEC excess capacity will be reduced. This will allow a gradual increase in prices in the latter years.

8. Refining capacity will be increased marginally as demand moves up. Crude throughput will move up along with demand. The refinery utilization rate will increase throughout the forecast period.

THE OUTLOOK — WORLDWIDE SUPPLY
SCENARIO — II

	1989	1990	1991	1992	1993	1994	1995	Change 1990 to 1995	% change 1990 to 1995
WORLD OIL PRODUCTION									
Total liquids									
(thousand barrels/day)									
OPEC	23,215	24,175	24,460	24,650	25,370	26,380	27,400	+3,225	+13.3
Non-OPEC	24,670	24,765	25,105	25,600	25,800	25,700	25,600	+835	+ 3.4
Total Non CPE's	**47,885**	**48,940**	**49,565**	**50,250**	**51,170**	**52,080**	**53,000**	**+4,060**	**+ 8.3**
Centrally Planned Economies (CPE's)	15,675	15,270	15,310	15,360	15,410	15,460	15,510	+ 240	+ 1.6
Total World	**63,560**	**64,210**	**64,875**	**65,610**	**66,580**	**67,540**	**68,510**	**+4,300**	**+ 6.7**
WORLD REFINING									
(thousand barrels/day)									
Capacity	74,400	74,700	74,950	75,000	75,300	75,550	75,800	+1,100	+ 1.5
Crude runs	59,495	60,415	61,040	61,730	62,640	63,550	64,460	+4,045	+ 6.7
Utilization rate (%)	80.0	80.9	81.4	82.3	83.2	84.1	85.0	+4.1	+ 5.1
World active drilling rigs (Excluding USSR & East Europe)									
Outside U.S. & Canada	922	940	1,010	1,050	960	1,000	1,025	+ 85	+ 9.0
Canada	130	135	175	180	150	165	185	+50	+37.0
U.S.	869	1,010	1,175	1,295	1,055	1,140	1,240	+230	+22.8
Total	**1,921**	**2,085**	**2,360**	**2,525**	**2,165**	**2,305**	**2,450**	**+365**	**+17.5**
Crude oil price									
Average world export price ($/barrel)	16.65	20.00	25.00	27.50	19.00	20.50	22.00	+2.00	+10.0

WORLDWIDE SUPPLY KEYS TO THE FUTURE SCENARIO III

1. There will be a very tight oil market as long as the dispute lasts in the Middle East. However, the dispute between Iraq and Kuwait is expected to be settled within 6 months. The embargo on oil from these two countries is expected to last for this period. Crude shortages may be experienced during the period of high seasonal demand in the winter of 1990–91. Prices will remain high only until the dispute is settled, possibly into early 1991. During the period of high prices, the growth in petroleum product demand may be reduced slightly.

2. It is expected that the dispute will be settled by early 1991. Production from Iraq and Kuwait will return to the market in 1991 and crude prices will fall in 1991. This should stimulate demand and result in a higher growth rate for world crude production.

3. The return of Iraqi and Kuwaiti oil will mean a return of excess production capacity which will put downward pressure on prices throughout the remainder of the forecast period. Coupled with some possible lapses in OPEC production discipline, this will keep crude prices well below the 1980–85 levels throughout the forecast period.

4. After the dispute is settled and prices fall, relatively low prices and economic growth will stimulate demand for petroleum products and crude oil throughout the remainder of the forecast period. Worldwide production will move up along with demand.

5. It is expected that OPEC will continue to be an effective cartel after this dispute has been resolved. Therefore throughout most of the forecast period OPEC's ability to set a realistic production quota and adhere to it will again play a major role in determining the price level. Control of OPEC will be dominated by the group of OPEC countries with huge reserves. This group will be led by Saudi Arabia and it is expected that OPEC will show some discipline and have periodic.

THE OUTLOOK — WORLDWIDE SUPPLY
SCENARIO — III

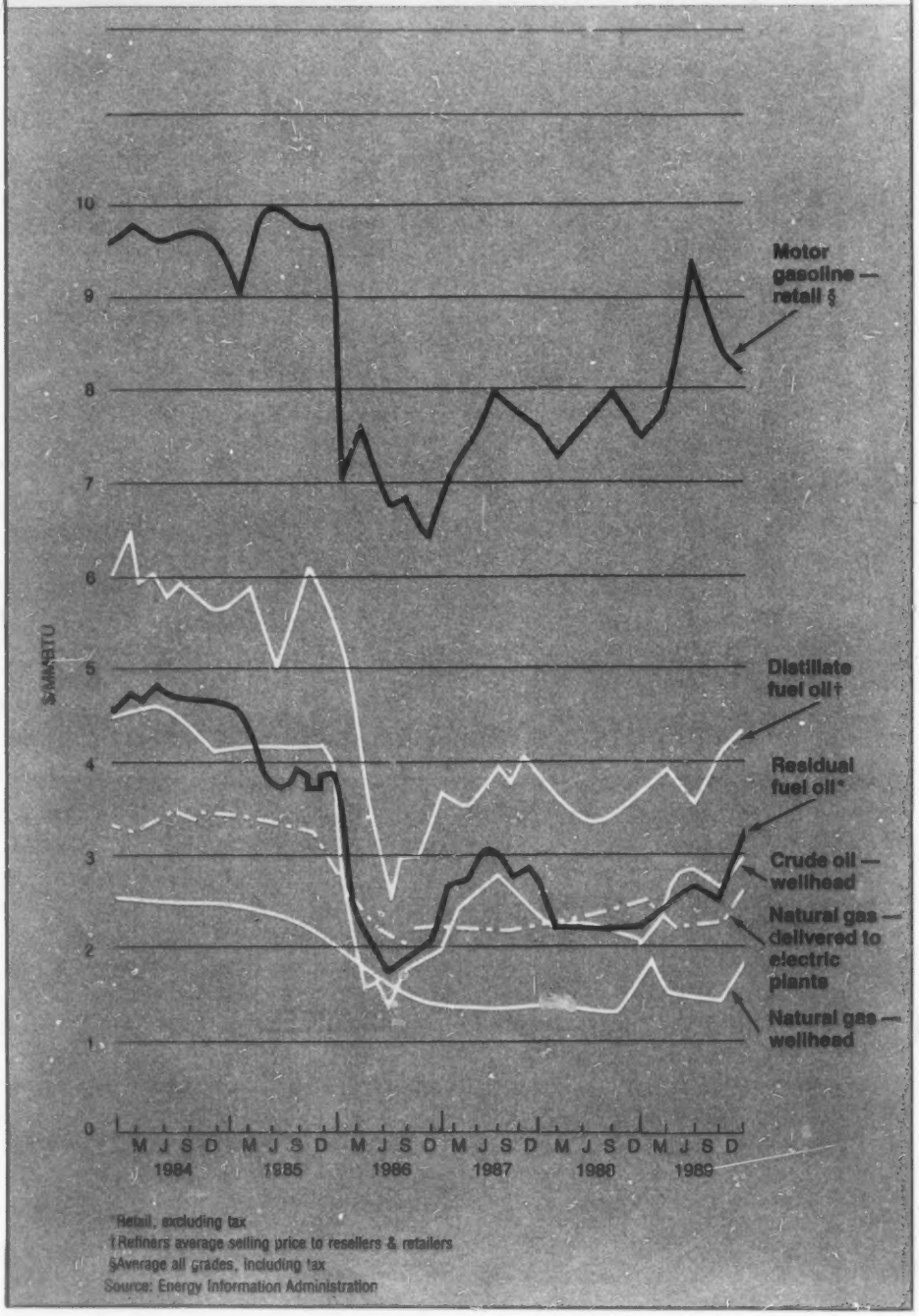
	1989	1990	1991	1992	1993	1994	1995	Change 1990 to 1995	% change 1990 to 1995
WORLD OIL PRODUCTION									
Total liquids									
(thousand barrels/day)									
OPEC	23,215	24,870	25,730	26,895	27,895	28,935	29,930	+5,060	+20.3
Non-OPEC	24,670	24,765	25,905	25,000	24,950	24,900	24,850	+ 85	+ 0.3
Total Non CPE's	**47,885**	**49,635**	**50,635**	**51,895**	**52,845**	**53,835**	**54,780**	**+5,145**	**+10.4**
Centrally Planned Economies									
(CPE's)	15,675	15,270	15,300	15,340	15,390	15,440	15,490	+ 220	+ 1.4
Total World	**63,560**	**64,905**	**65,935**	**67,235**	**68,235**	**69,275**	**70,270**	**+5,365**	**+ 8.3**
WORLD REFINING									
(thousand barrels/day)									
Capacity	74,400	74,700	75,200	75,700	76,300	76,800	77,400	+2,700	+ 3.6
Crude runs	59,495	60,750	61,710	62,925	63,860	64,830	65,760	+5,010	+ 8.2
Utilization rate (%)	80.0	81.3	82.1	83.1	83.7	84.4	85.0	+3.7	+ 4.6
World active drilling rigs									
(Excluding USSR & East Europe)									
Outside U.S. & Canada	922	935	950	975	1,000	1,015	1,025	+ 90	+ 9.6
Canada	130	135	145	155	165	175	185	+50	+37.0
U.S.	869	1,005	1,025	1,115	1,170	1,240	1,305	+300	+29.9
Total	**1,921**	**2,075**	**2,120**	**2,245**	**2,335**	**2,430**	**2,515**	**+440**	**+21.2**
Crude oil price									
Average world export price ($/barrel)	16.65	19.50	18.00	20.00	21.00	22.00	23.00	+3.50	+17.9

U.S. OUTLOOK—DEMAND

The United States economy is quite dependant upon foreign oil. Therefore the recent events in the Middle East will have a substantial impact on the demand for oil and energy in the United States.

The embargo of oil exported from Iraq and Kuwait means that a substantial volume of oil has been removed from the world market. This was oil that could have been used to supply worldwide demand both in the United States and elsewhere.

PETROLEUM PRODUCT AND NATURAL GAS PRICES



*Retail, excluding tax
†Refiners average selling price to resellers & retailers
§Average all grades, including tax
Source: Energy Information Administration

The removal of this oil from the world market has tightened the market by removing a great deal of the excess capacity. The tight market has resulted in a substantial increase in the world price of oil and the price of petroleum products in the U.S. Oil prices have reached levels that have not been seen for the past five years.

It is too early to determine if these substantially higher prices have had an impact on demand for petroleum products in the United States. But if these high prices are sustained for an extended period, there will undoubtedly be a demand response. Petroleum demand is relatively inelastic in the short term. But demand is more flexible than it was during the earlier periods when prices moved up rapidly. A great deal of multiple fuel capacity has been built into U.S. industry. And U.S. consumers have had some past experience with discretionary conservation.

U.S. demand for petroleum products has been on the rise since 1983. The lower level of crude oil and product prices has stimulated consumption. The lower oil prices that have prevailed since 1986 have had a substantial impact on the demand for petroleum products in the United States. The sharp drop in prices in 1986 stimulated demand and brought about the largest year-to-year increase in consumption of petroleum products since 1977. Although not quite as large, a substantial increase in consumption was also posted in 1987. The sharp drop in prices in 1988 repeated this cycle and demand moved up even more than in 1986, continuing to climb modestly in 1989.

Demand has exhibited a close relationship to the price level over the past decade. This has dispelled the theory that oil demand is impervious to price, or that in economic terms it is totally inelastic. After decades of steadily increasing, oil demand was stopped in its tracks in 1978 and reversed by rapidly escalating oil prices. This was after an almost unbroken string of annual increases in consumption dating back to the 1920s.

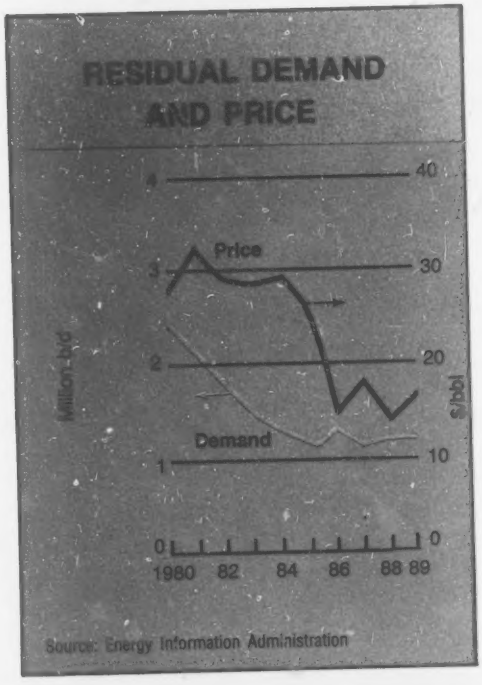
It took some time for the fact to sink in that oil demand does respond to prices. The price changes had to be major in order to make a significant impact on the level of demand. But it did become apparent that a great deal more attention would have to be paid to the relationship between oil demand and price in all future analyses and projections.

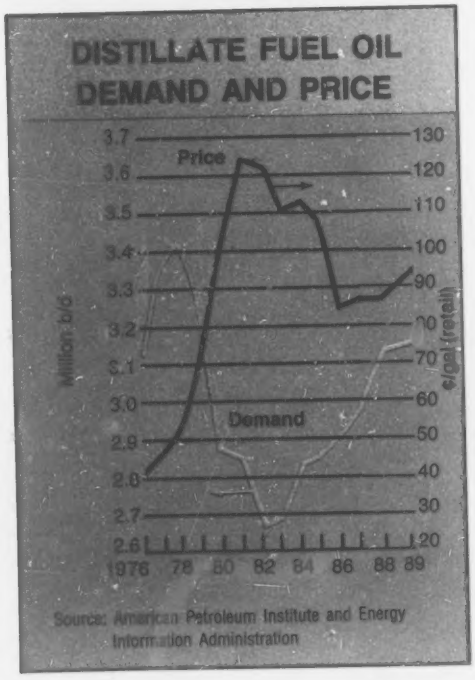
However, it isn't only the price of oil that has to be considered in any projection, it is also the cost of competing energy sources. Rising energy costs in the 1970s and early 1980s led to conservation and to fuel switching and multiple fuel capabilities. As energy costs rose, it became apparent to large energy consumers that the most cost-effective way to meet their energy needs was through investment in multiple fuel capacity and conservation. With fuel switching capability they could easily switch their consumption to the lowest-cost fuel available. This substantially increased the competition between fuels. And as a result, the prices of competing fuels tend to closely track each other.

However, substantial differences can arise when there are significant changes in fuel supply markets. As competing fuels adjust prices to obtain a competitive advantage or in reaction to shifts in raw material costs, the swings in demand can be substantial. This happened in 1986 with respect to petroleum products. The precipitous drop in prices enabled petroleum to recapture a portion of some fuel markets it had lost in earlier years.

An additional factor that has an impact on demand for petroleum or energy in general is the level of the conservation effort. At lower prices the incentive to invest in conservation capital equipment or fuel switching capital equipment is substantially diminished. And the discretionary conservation exhibited by consumers under higher prices is also greatly reduced. In the years of declining demand the discretionary conservation of individual consumers has a large impact on the level of consumption of motor gasoline and fuel oils for home heating and cooling.

All of these factors have contributed to





the increased consumption of petroleum products over the past several years. Petroleum regained some of its competitive advantages as a fuel, and the conservation incentive was reduced. This may have been changed recently by the hostilities in the Middle East.

The size of the U.S. oil industry in terms of revenue and investment has diminished over the past few years. But it should be remembered that the U.S. economy is still driven to a large extent by the consumption of petroleum and natural gas. These two fuels still provide almost two-thirds of U.S. energy. And their significance will be reduced only marginally over the forecast period. What happens in the oil and gas industry over the next five years is an important part of what happens to the U.S. economy.

REVIEW

ENERGY DEMAND. The level of economic growth or activity is the major determinant of the demand for energy. The type of economic activity also plays a role in determining the level of energy demand. However, it has become evident, particularly in recent years, that the level of energy demand is also closely related to the cost of energy. The degree of energy conservation and degree of efficiency desired is dependent upon the cost of energy relative to other costs of production and goods.

The demand for crude oil, petroleum products and natural gas in the United States, is related to all of the factors mentioned above, i.e., economic activity, overall energy demand and the cost of energy. Therefore, it is worthwhile to have an understanding of the past trends and relationships among these factors before determining the level of petroleum demand.

Since 1973, the U.S. economy has gone through two recessions. Both followed major increases in oil prices and in energy costs in general. One recession was in 1974–75 when real

Gross National Product (GNP), expressed in 1982 dollars, fell 1.8% over two years. The second occurred in 1982, when real GNP fell 2.5%. Between 1978 and 1982 the economy was almost at a standstill with growth of only 1.6%. The U.S. economy began pulling out of the most recent recession during 1983. Real GNP moved up 3.5% in 1983. The pace of economic growth accelerated in 1984 with real GNP increasing 6.4%. Since then the economy has been growing at a modest but steady pace, 3.4% in 1985, 2.7% in 1986, 3.7% in 1987, 4.4% in 1988 and 3.0% in 1989.

The lockstep relationship between economic growth and energy demand in the U.S. was broken in 1970. From 1950 through 1970, real GNP increased 100.2%. Over the same period, energy consumption increased 97.5%. The amount of energy consumed per real dollar of GNP fell only slightly, from 28,200 BTU per dollar of GNP in 1950 to 27,800 BTU in 1970. Economic growth during that period was being fueled by cheap energy. Growth was primarily in the industrial sector which was relatively energy-intensive. With energy quite inexpensive, there was little if any incentive for energy conservation. So energy consumption grew as fast as economic output.

This changed markedly in the 1970s when the cost of energy began to increase. And the change continued through the 1980s. From 1970 through 1989, GNP increased 71.5%, but energy consumption moved up only 21.1%. Over that 19 year period, the growth of energy and GNP moved from a one-to-one relationship to a 0.29-to-one relationship, meaning that energy consumption increased only 2.9% for every 10% increase in economic activity. This was a dramatic shift from the previous 20 years. The energy consumption has gone up faster in the past few years. This ratio was much lower for the period 1970–84.

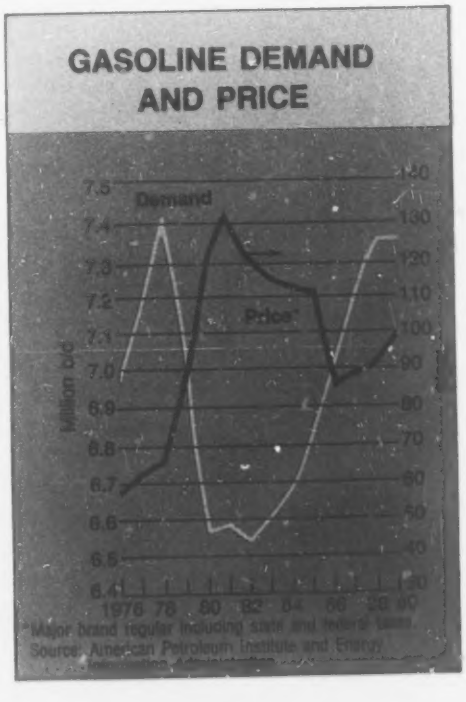
Total energy consumption per GNP dollar fell for 18 consecutive years, from 27.8 thousand BTU in 1970 to 19.6 thousand in 1989. Over those 19 years there was a 29.5% improvement in the efficiency of energy consumed.

PRICES* OF FOSSIL FUELS USED IN ELECTRIC GENERATION

	Coal	Residual oil	Natural gas	All fossil fuels	Residual oil price as % of Coal	Residual oil price as % of Natural gas
	(¢/MMBTU)					
1974	70.9	189.0	48.2	91.4	266.6	392.1
1975	81.4	200.5	75.2	104.4	246.3	266.6
1976	84.8	195.2	103.4	111.9	230.2	188.8
1977	94.7	219.8	129.1	129.7	232.1	170.3
1978	111.6	212.5	142.2	141.1	190.4	149.4
1979	122.4	298.8	174.9	163.9	244.1	170.8
1980	135.1	426.7	219.9	192.8	315.8	194.0
1981	153.2	533.4	280.5	225.6	348.2	190.2
1982	164.7	483.2	337.6	224.9	293.4	143.1
1983	165.6	457.8	347.4	220.6	276.4	131.8
1984	166.4	481.2	360.3	219.1	289.2	133.5
1985	164.8	424.4	344.4	209.4	257.5	123.2
1986	157.9	240.1	235.1	175.0	152.1	102.1
1987	150.6	297.6	224.0	170.6	197.6	133.9
1988	146.6	240.5	226.3	164.3	164.1	106.3
1989	144.5	284.6	235.5	167.5	197.0	120.8

*Delivered price to steam-electric utility plants.

Source: Energy Information Administration



FACTORS DETERMINING MOTOR GASOLINE DEMAND

	Total vehicle registrations* (1,000)	Total vehicle miles of travel (Billion)	Car registrations (1,000)	Average age of cars	Fuel consumed per car (Gallons)	Miles traveled per car	Miles per gallon
1970	108,418	1,109.7	89,244	5.6	760	10,272	13.52
1975	132,949	1,327.7	106,706	6.0	716	9,690	13.52
1980	155,796	1,527.3	121,601	6.6	591	9,141	15.46
1982	159,643	1,592.5	123,702	7.2	566	9,428	16.65
1984	166,249	1,720.3	128,158	7.5	536	9,558	17.83
1985	171,654	1,774.2	131,864	7.6	525	9,560	18.20
1986	176,191	1,834.9	135,431	7.6	526	9,608	18.32
1987	179,044	1,921.2	137,324	7.6	514	9,878	19.17
1988	184,397	2,025.6	141,252	7.6	507	10,119	19.95

*Excludes military vehicles.

Source: Motor Vehicle Manufacturers Assoc. Facts & Figures Report 1990, EIA

CRUDE OIL PRICES

	Saudi Light (Jan.1)	U.S. average wellhead	— Refiners' acquisition cost — Domestic	Imported	Composite
	(Dollars per barrel)				
1970	1.35	3.18	3.46	2.96	3.40
1971	1.75	3.39	3.68	3.17	3.60
1972	1.90	3.39	3.67	3.22	3.58
1973	2.10	3.89	4.17	4.08	4.15
1974	10.84	6.87	7.18	12.52	9.07
1975	10.46	7.67	8.39	13.93	10.38
1976	11.51	8.19	8.84	13.48	10.89
1977	12.09	8.57	9.50	14.53	11.96
1978	12.70	9.00	10.61	14.57	12.46
1979	13.34	12.64	14.27	21.67	17.72
1980	26.00	21.59	24.23	33.89	28.07
1981	32.00	31.77	34.33	37.05	35.24
1982	34.00	28.52	31.22	33.55	31.87
1983	34.00	26.19	28.87	29.30	28.99
1984	29.00	25.88	28.53	28.88	28.63
1985	29.00	24.09	26.66	26.99	26.75
1986	28.00	12.51	14.82	14.00	14.55
1987	16.15	15.40	17.76	18.13	17.90
1988	17.52	12.58	14.74	14.56	14.67
1989	13.15	15.85	17.88	18.08	17.96
Change 1981-1989	−18.85	−15.92	−16.45	−18.97	−17.27
% change 1981-1989	−58.9%	−50.1%	−47.9%	−51.2%	−49.0%
Change 1970-1989	11.80	12.67	14.42	15.12	14.57
% change 1970-1989	874.1%	398.4%	416.8%	510.8%	428.5%

Source: Energy Information Administration

The rapid increase in the price of energy in the 1970s was a major reason for the improvement in energy efficiency. The rising cost of energy relative to other factors of production provided a cost-cutting and profit incentive for minimizing energy requirements.

The oil price hikes of 1973–74 and 1979–81 rapidly boosted the cost of petroleum products and the cost of energy in general. This had the effect of providing additional incentive for conservation and accelerated the drop in energy used per dollar of GNP.

Following the 1973–74 price hike, the economy went into a recession, with real GNP falling in 1974 and 1975. Energy consumption fell from 74,282 trillion BTU in 1973 to 70,546 trillion BTU in 1975, a decline of 5%. Following the 1979–81 price hike, the economy again went into a recession in 1982. Due to the price-induced conservation, energy consumption actually started falling in 1980, and the fall accelerated with the drop in economic activity. Energy consumption fell for four consecutive years, dropping 10.7%, from 78,898 trillion BTU in 1979 to 70,497 trillion BTU in 1983.

Since 1981, oil prices have been falling and other energy costs have also dropped. This has moderated the incentive for conservation. During 1984, real GNP increased 6.8% and energy consumption moved up 5.1%. This is a ratio of 0.75 to 1, and is a sharp increase in relative energy consumption. But conservation has not stopped completely. In 1985, GNP increased 3.4% while energy consumption fell 0.2%. In 1986, GNP increased 2.7% while energy consumption only moved up 0.4%. In 1987, GNP was up 3.7% and energy consumption up 3.4%. In 1988, GNP increased 4.4% and energy consumption also moved up 4.4%. In 1989, GNP increased 3.0% and energy consumption moved up 1.3%. Energy conservation has continued even if the incentive has been muted.

The consumption of petroleum energy per dollar of real GNP also fell after the second oil price hike in 1979. Petroleumm energy consumed per dollar of GNP fell from 12.5 thousand BTU in 1977 to 8.6 thousand BTU in 1985. In 1986, it moved up to 8.7 thousand BTU as oil demand increased at a rate higher than GNP. But it fell again in 1987 to 8.5 thousand BTU per dollar of GNP. And it remained at that level in 1988. It fell to 8.3 thousand BTU in 1989.

A substantial part of the more efficient use of energy has been due to price induced con-

REFINED PETROLEUM PRODUCTS SUPPLIED BY TYPE

	Motor gasoline	% of total	Jet fuel	% of total	Distillate fuel oil	% of total	Residual fuel oil	% of total	Ethane and liquefied gases	% of total	Other products	% of total	Total products	% of total	% change from previous year
	(Million b/d)														
1974	6.54	39.3	0.99	5.9	2.95	17.7	2.64	15.8	1.41	8.5	2.12	12.8	16.65	100.0	−3.8
1975	6.68	40.9	1.00	6.1	2.85	17.5	2.46	15.1	1.33	8.1	2.01	12.3	16.32	100.0	−2.0
1976	6.98	40.0	0.99	5.6	3.13	17.9	2.80	16.0	1.40	8.1	2.16	12.4	17.46	100.0	7.0
1977	7.18	38.9	1.04	5.6	3.35	18.2	3.07	16.7	1.42	7.7	2.37	12.9	18.43	100.0	5.6
1978	7.41	39.3	1.06	5.6	3.43	18.2	3.02	16.0	1.41	7.5	2.52	13.4	18.85	100.0	2.3
1979	7.03	38.0	1.08	5.8	3.31	17.9	2.83	15.3	1.59	8.6	2.67	14.4	18.51	100.0	−1.8
1980	6.58	38.6	1.07	6.3	2.87	16.8	2.51	14.7	1.47	8.6	2.56	15.0	17.06	100.0	−7.8
1981	6.59	41.0	1.01	6.3	2.83	17.6	2.09	13.0	1.47	9.1	2.07	13.0	16.06	100.0	−5.9
1982	6.54	42.7	1.01	6.6	2.67	17.5	1.72	11.2	1.50	9.8	1.86	12.2	15.30	100.0	−4.7
1983	6.62	43.5	1.04	6.8	2.69	17.7	1.42	9.3	1.51	9.9	1.95	12.8	15.23	100.0	−0.5
1984	6.69	42.5	1.18	7.5	2.84	18.1	1.37	8.7	1.57	10.0	2.08	13.2	15.73	100.0	3.3
1985	6.83	43.4	1.22	7.8	2.87	18.2	1.20	7.6	1.60	10.2	2.01	12.8	15.73	100.0	—
1986	7.03	43.2	1.30	8.0	2.91	17.9	1.42	8.7	1.51	9.3	2.11	12.9	16.28	100.0	3.5
1987	7.21	43.3	1.39	8.3	2.98	17.9	1.26	7.6	1.61	9.7	2.22	13.2	16.67	100.0	2.4
1988	7.34	42.5	1.45	8.4	3.12	18.1	1.38	8.0	1.66	9.6	2.33	13.5	17.28	100.0	3.7
1989	7.33	42.4	1.49	8.6	3.16	18.2	1.37	7.9	1.67	9.6	2.31	13.3	17.33	100.0	0.3

Source: Energy Information Administration

servation following the rapid and sharp increase in energy costs. But the shift in the profile of the economy has also been an important factor. The U.S. is moving from a principally industrial economy to a more service- and information-oriented economy. The service and information types of economic activity are far less energy intensive than industrial activity.

It should also be pointed out that the response to price increases can be spread out over an extended period. It can be rapid in the transportation sector, but is generally much slower in the residential/commercial, utility and industrial sectors. In those latter sectors, adjustment can extend over 5 to 10 or more years. A major portion of this type of demand adjustment is permanent, since it is due to investment in improved capital goods.

In the U.S. there has been a shift in energy consumption, away from the industrial sector to the residential/commercial and transportation sectors. Consumption in the industrial sector dropped from 31.54 quads in 1973 to 25.75 quads in 1983, a drop of 18.4%. The industrial sector share of total energy consumption dropped from 42.5% to 36.5%. This reflects conservation and more efficient use of energy in the industrial sector, as well as the diminishing importance of the industrial sector in the total economy.

There was a rebound in energy consumption by the industrial sector in 1984. Energy consumption in this sector moved up 7.7% to 27.74 quads, 37.4% of total energy. One of the major reasons for the surge in energy consumption in 1984 was the economic improvement in the more energy intensive industrial sector.

Industrial consumption of energy slipped a bit in 1985 to 27.08 quads, 36.6% of the total energy consumed. It slipped again in 1986 to 26.45 quads, down 2.3%. This was 35.6% of total energy consumed. There was a rebound to 27.65 quads in 1987, up 4.5%. This was 36% of total energy consumed. Industrial energy consumed moved up another 4.1% in 1988, to 29.01 quads. This was 36.2% of total energy. It moved up another 2.1% in 1989, to 29.61 quads, 36.4% of total energy. Expectations are that the relative importance of the industrial sector will continue to slide in the future, but the recent upturn in economic activity and industrial output has slowed the slide.

Residential/commercial sector energy consumption has increased from 24.14 quads in 1973 to 29.5 quads in 1989, an increase of 22.2%. This sector's share of the total market increased from 32.5% to 36.3%. The growth in this sector of the economy has more than offset the improvement in energy efficiency and conservation.

U.S. ENERGY CONSUMPTION BY SOURCE

	Petroleum	% of total	Natural gas	% of total	Coal	% of total	Nuclear	% of total	Hydro and other	% of total	Total
					(Quadrillion BTU)						
1974	33.455	46.1	21.732	30.0	12.663	17.5	1.272	1.8	3.421	4.6	72.543
1975	32.731	46.4	19.948	28.3	12.663	17.9	1.900	2.7	3.303	4.7	70.545
1976	35.175	47.3	20.345	27.4	13.584	18.3	2.111	2.8	3.147	4.2	74.362
1977	37.122	48.7	19.931	26.1	13.922	18.2	2.702	3.5	2.612	3.5	76.289
1978	37.965	48.6	20.000	25.6	13.765	17.6	3.024	3.9	3.335	4.3	78.089
1979	37.123	47.1	20.666	26.2	15.039	19.1	2.776	3.5	3.293	4.1	76.898
1980	34.202	45.0	20.394	26.9	15.423	20.3	2.739	3.6	3.197	4.2	75.955
1981	31.931	43.2	19.928	26.9	15.907	21.5	3.008	4.1	3.216	4.3	73.990
1982	30.231	42.7	18.505	26.1	15.322	21.6	3.131	4.4	3.659	5.2	70.848
1983	30.054	42.6	17.357	24.6	15.894	22.6	3.203	4.5	4.016	5.7	70.524
1984	31.051	41.9	18.507	25.0	17.070	23.0	3.553	4.8	3.920	5.3	74.101
1985	30.922	41.8	17.834	24.1	17.478	23.7	4.149	5.6	3.562	4.8	73.945
1986	32.196	43.4	16.708	22.5	17.262	23.3	4.471	6.0	3.600	4.8	74.237
1987	32.865	43.1	17.668	22.5	18.008	23.6	4.906	6.4	3.278	4.4	76.768
1988	34.228	42.7	18.551	23.1	18.846	23.5	5.661	7.1	2.914	3.6	80.200
1989	34.211	42.1	19.358	23.8	18.916	23.3	5.687	7.0	3.104	3.8	81.276

Source: Energy Information Administration

Growth in this sector is expected to be slow but steady over the forecast period, reflecting the shift to a more service- and information-oriented economy.

Consumption of energy in the transportation sector has also increased over this period, moving up 19.2%, from 18.60 quads in 1973 to 22.17 quads in 1989. The share of total energy consumption increased from 25% to 27.3%. Although there has been continued improvement in vehicle fuel efficiency, the total vehicle fleet has been increasing along with the population. And as gasoline and diesel fuel prices have leveled off during the past few years, there has been less incentive for discretionary conservation. Energy consumption in this sector was up 14.5% over the five years, 1983-1988.

There has not only been a shift in the end use of energy, but also a shift in the source of energy. Over the past 15 years, coal and nuclear energy have been increasing their share of the energy market, while petroleum and natural gas have been declining.

The increase in demand for energy in the form of electrical power has been the primary reason for the increase in coal consumption and nuclear power generation. This is due to the changing nature of the economy. This is also part of the shift to a more service-oriented, information-oriented and automatedn economy.

Coal energy consumption moved up 34.7% between 1973 and 1985. Coal increased its share of the total energy market from 17.5% to 23.6% in 1985. Coal consumption fell 1.2% in 1986 and coal's market share slipped to 23.3%. Coal rebounded in 1987, moving up 4.3%. The market share moved back up to 23.5%. In 1988, coal energy consumption increased another 4.6%. Share of the market stayed at 23.5%. Coal consumption increased 0.4% in 1989 and the market share dropped to 23.2%.

In 1986, a sluggish economy, particularly in the industrial sector, had an impact on coal. And coal found itself losing market share to cheap residual fuel oil. That was only a temporary phenomenon but it did signal the possibility of oil recapturing some of the utility and industrial sector if the price was competitive. Multi-fuel capability makes fuel switching much easier now than in past years.

Energy from nuclear electric power increased 525%, from 0.91 quads in 1973 to 5.69 quads in 1989. The nuclear share of the energy market increased from 1.2% in 1973 to 7.0% in 1989.

Other forms of energy, primarily hydroelectric and geothermal, provided only 3.8% of total energy consumed in 1989. This is down from

REFINED PRODUCT PRICES

	Regular motor gasoline pump price (¢/gal)	No. 2 heating oil retail price (¢/gal)	Average landed cost of crude imports ($/bbl)	Refiners' acquisition cost composite ($/bbl)
1977	63.07	47.37	14.31	11.96
1978	65.71	50.80	14.38	12.46
1979	87.79	72.80	21.65	17.72
1980	121.72	100.97	33.95	28.07
1981	131.10	124.66	36.52	35.24
1982	122.20	120.86	33.18	31.87
1983	115.70	110.12	28.93	28.99
1984	112.90	111.97	28.46	28.63
1985	111.50	107.55	26.66	26.75
1986	85.70	83.45	13.49	14.55
1987	89.70	85.15	17.65	17.90
1988	89.90	84.63	14.08	14.67
1989	99.80	93.95	17.68	17.97

Source: Energy Information Administration
U.S. Dept. of Labor

4.1% in 1973. Some of this is a temporary weather-related drop in energy output from hydropower. Most of this energy comes from hydropower, where the maximum capacity cannot change easily from year to year and output is dependent upon the weather. Low rainfall and snowfall reduced hydropower in 1987 through 1989.

Over the 1973 to 1985 period, the petroleum share of the energy market fell from 46.9% to 41.8%. Energy from petroleum in 1985 was 11.2% lower than 1973, while total energy consumption was down only 0.5%. Lower prices boosted petroleum consumption in 1986 and it increased 4.1%, capturing 43.4% of the energy market. It slipped to 42.8% of the market share in 1987, 42.7% in 1988, and 42.1% in 1989 as energy demand moved up faster than petroleum demand.

The natural gas share of the total energy market has fluctuated more from year to year than has petroleum, but it has also moved down since 1973. Natural gas represented 30.3% of the market in 1973, but was down to 22% in 1987. It moved up slightly to 23.1% in 1988 and 23.8% in 1989. Natural gas lost some market share to cheap residual fuel oil in the industrial and utility markets, when prices were low in 1986. Natural gas consumption fell to 16.71 quads in 1986, down 25.8% from 1973. It moved back up to 17.75 quads in 1987, 18.55 quads in 1988 and 19.36 quads in 1989.

In 1973, petroleum and natural gas combined accounted for 77.2% of the energy consumed in the United States. This was down to 65.9% in 1989, a definite downward trend, but still almost two-thirds of all energy consumed in the United States.

FUEL COMPETITION. Adjustment to the rising cost of energy not only took the form of conservation but also the form of fuel switching. The transition to a greater capacity for fuel switching took time. It was a reaction to the price shift that was spread out over several years. It required a substantial capital investment in most cases and therefore was dependent upon a more lengthy complex economic evaluation, an evaluation which included the capital investment cost of alternative fuel facilities.

It is evident from the 1986 and 1987 energy statistics that substantial multi-fuel capability is available in the industrial and utility sectors and, to a lesser extent, in the residential sector. This has enabled some end-users to adjust their energy consumption and choose the lowest-cost fuel. In many instances in 1986, this turned out to be fuel oil. And it was a surprise to see a rebound in heavy fuel oil consumption.

Although slow to react, natural gas prices and coal prices were forced to adjust to the competition from fuel oil. When fuel oil prices moved back up in 1987, demand for fuel oil dropped and demand for coal and natural gas rebounded. The net result of this substantial multi-fuel capacity is to keep the BTU cost of competing fuels quite close to each other.

The most competitive interfuel market is in the industrial and utility sectors where residual fuel oil competes directly with both natural gas and coal. And the demand for residual fuel oil is also affected by the expansion of nuclear fuel capacity for generating electricity.

ECONOMIC GROWTH AND ENERGY CONSUMPTION

	GNP constant 1982 dollars (Billion)	Total energy consumption (Trillion BTU)	Total energy consumption per GNP dollar (Thousand BTU)	Petroleum energy consumption (Trillion BTU)	Petroleum energy consumption per GNP dollar (Thousand BTU)
1929	711.8	23,756	33.4	5,521	7.8
1933	501.6	16,900	33.7	4,833	9.6
1940	775.0	23,589	30.4	7,407	9.6
1946	1,077.8	30,494	28.3	10,002	9.3
1950	1,206.6	33,992	28.2	13,489	11.2
1955	1,494.9	39,703	26.6	17,524	11.7
1960	1,665.3	44,569	26.8	20,067	12.1
1965	2,087.6	53,343	25.6	23,242	11.1
1970	2,416.2	67,143	27.8	29,537	12.2
1971	2,484.8	68,348	27.5	30,570	12.3
1972	2,608.5	71,643	27.5	32,966	12.6
1973	2,744.1	74,282	27.1	34,840	12.7
1974	2,729.3	72,543	26.6	33,455	12.3
1975	2,695.0	70,546	26.2	32,731	12.1
1976	2,826.7	74,362	26.3	35,175	12.4
1977	2,958.6	76,289	25.8	37,122	12.5
1978	3,115.2	78,088	25.1	37,965	12.2
1979	3,192.4	78,898	24.7	37,123	11.6
1980	3,187.1	75,952	23.8	34,202	10.7
1981	3,248.8	73,989	22.8	31,931	9.8
1982	3,166.0	70,840	22.4	30,232	9.5
1983	3,279.1	70,497	21.5	30,054	9.2
1984	3,501.4	74,101	21.2	31,051	8.9
1985	3,619.0	73,945	20.4	30,922	8.5
1986	3,718.0	74,237	20.0	32,196	8.7
1987	3,854.0	76,768	19.9	32,865	8.5
1988	4,024.4	80,135	19.9	34,209	8.5
1989	4,114.1	81,240	19.6	34,025	8.2
1990E	4,221.1	81,690	19.4	33,940	8.0
Percentage change:					
1929-40	+8.9	−0.7	−9.0	+34.2	+23.1
1940-50	+55.7	+44.1	−7.2	+82.1	+16.7
1950-70	+100.2	+97.5	−1.4	+119.0	+8.9
1970-89	+71.5	+21.0	−29.5	+15.2	−34.4

E - Estimate
Source: Energy Information Administration

The cost of fuels delivered to steam-electric utility plants gives a good picture of how the relative cost of competing fuels has shifted over the past several years. Coal has been, and still is, the cheapest fuel, followed by natural gas, and then heavy fuel oil, or resid, as the most expensive. But the price differentials between the fuels has changed over time. And for a short period of time in 1986 there was an unprecedented change: for the first time the cost of resid fell below that of natural gas.

In 1973, the cost of heavy oil for steam-electric utility plants was 193.8% of the cost of coal, and heavy oil was 232.2% of the cost of natural gas. These relative prices moved up to heavy oil 348.2% of coal, and 190.2% of natural gas, in 1981. Natural gas prices were also moving up rapidly over this period. The utility plant average cost for all fossil fuels increased 373.9% from 1973 to its peak in 1981. Since 1981, heavy fuel costs have fallen considerably. The costs of coal and natural gas slowed their rate of increase during the 1981–84 period, and fell slightly in 1985. For the year 1985, the cost of heavy oil for utilities was 257.5% of coal and 123.7% of natural gas. As oil prices plummeted in 1986, the relationship changed rapidly. For the first time, in April 1986, the cost of heavy fuel oil to the utility plants fell below the cost of natural gas.

By July 1986, resid prices had fallen 56.6% from the December 1985 price. At that time the resid price was 117.2% of coal and only 85.2% of natural gas.

In the face of this stiff competition from residual fuel oil, both natural gas prices and coal prices fell. Resid prices began to move up again toward the end of 1986, and by November resid had lost its absolute price advantage over natural gas.

The average price of resid delivered to electric utility plants for 1986 was down 43.4%. And for the year the resid price was 152.1% of coal and 102.4% of natural gas. This was a substantial change in the competitive differentials, from those in 1981.

During 1986, the cost of coal to electric utilities fell 4.2% and the cost of natural gas was down 31.7%. The average cost for all fuels fell 16.5%. This is a good example of the intense competition between the fuels.

The 1986 price competition from fuel oil brought the cost of these competing fuels much closer together than they had been in years. During 1987, resid prices moved up along with crude prices. The cost of heavy fuel oil for steam-electric utility plants increased 23.9%. But coal and natural gas prices fell as they attempted to recapture this market. The cost of coal fell 4.6% and natural gas slipped 4.7%. For all of 1987, the resid price averaged 197.6% of coal and 133.2% of natural gas. The next year, 1988, was almost a repeat of

1986. The cost of heavy fuel oil fell 19.3%. Coal costs fell 2.6%, but natural gas moved up 1.3%. Heavy fuel oil costs were 163.8% of coal and only 106.1% of natural gas. Fuel oil gained a bit of the market with the lower prices. In 1989, heavy fuel costs moved up faster than the other two fuels. The cost of heavy fuel oil increased 18.3%, natural gas increased 4.1% and coal cost fell 1.4%. Heavy fuel oil costs in 1989 were 197% of coal and 120.8% of natural gas.

Compared to the peak in 1981, the average cost of all fossil fuels for electric utilities was down 26.8% in 1989. The cost of heavy oil was down 46.6%, natural gas down 16.2% and coal down 5.7%.

It is expected that with the extensive multi-fuel capacity and the lower price level for crude oil, their relative prices will remain quite close and competitive.

There are a couple of other factors which also may have an impact on this fuel competition. With repeal of the Fuel Use Act, the limitation on the use of natural gas by heavy industry and utilities is eliminated. And environmental concerns over coal use may make it a more costly fuel if substantial investment is required to meet environmental restrictions. This could make both residual fuel oil and natural gas more competitive in that market.

PETROLEUM PRODUCT DEMAND. At the lower price level that has prevailed over the past few years, demand for petroleum products has moved up significantly. Demand increased 555,000 b/d in 1986. At the time that was the largest year-to-year increase in petroleum product demand since 1977. Demand moved up an additional 384,000 b/d in 1987, then jumped up 618,000 b/d in 1988, but only moved up 42,000 b/d in 1989.

Prior to the sharp price hike in the 1979–81 period, it was felt that petroleum demand was not related to or affected by the price level. But at that time it also was not thought that the price of crude oil could take such gigantic swings.

The initial sharp increase in prices took analysts by surprise in the 1970s and early 1980s. And the sharp drop in oil prices in 1986 took the vast majority of analysts by surprise again.

When prices moved up sharply in 1979–81, petroleum demand reacted and began to fall. Petroleum demand in the U.S. peaked in 1978 just prior to the second price shock and then fell for five consecutive years. This decline was unprecedented in duration. Domestic demand for petroleum products had increased for 31 consecu-

ENERGY CONSUMPTION—END USER SECTOR

	Residential and commercial	% of total	Industrial	% of total	Transportation	% of total	Total energy consumption
	(Quadrillion BTU)						
1974	23.72	32.7	30.70	42.3	18.12	25.0	72.54
1975	23.90	33.9	28.40	40.3	18.25	25.8	70.55
1976	25.02	33.6	30.23	40.7	19.11	25.7	74.36
1977	25.39	33.3	31.08	40.7	19.82	26.0	76.29
1978	26.09	33.4	31.39	40.2	20.61	26.4	78.09
1979	25.81	32.8	32.62	41.3	20.47	25.9	78.90
1980	25.65	33.8	30.61	40.3	19.70	25.9	75.96
1981	25.24	34.1	29.24	39.5	19.51	26.4	73.99
1982	25.63	36.2	26.14	36.9	19.08	26.9	70.85
1983	25.63	36.3	25.75	36.5	19.14	27.1	70.52
1984	26.50	35.8	27.73	37.4	19.87	26.8	74.10
1985	26.73	36.1	27.12	36.7	20.10	27.2	73.95
1986	26.83	36.1	26.65	35.9	20.76	28.0	74.24
1987	27.62	35.9	27.87	36.3	21.36	27.8	76.85
1988	29.00	36.2	29.01	36.2	22.19	27.7	80.20
1989	29.50	36.3	29.61	36.4	22.17	27.3	81.28

Source: Energy Information Administration

REFINED PETROLEUM PRODUCTS SUPPLIED TO END-USE SECTORS

	Residential and commercial	% of total	Industrial	% of total	Trans.	% of total	Electric utilities	% of total	Total	% of total
	(Million b/d)									
1974	2.04	12.2	4.30	25.8	8.84	53.1	1.48	8.9	16.66	100.0
1975	1.95	11.9	4.04	24.8	8.95	54.8	1.39	8.5	16.33	100.0
1976	2.12	12.1	4.45	25.5	9.37	53.7	1.52	8.7	17.46	100.0
1977	2.14	11.6	4.82	26.2	9.76	52.9	1.71	9.3	18.43	100.0
1978	2.07	11.0	4.87	25.8	10.16	53.9	1.75	9.3	18.85	100.0
1979	1.73	9.3	5.34	28.9	10.01	54.0	1.44	7.8	18.52	100.0
1980	1.52	8.9	4.84	28.4	9.55	56.0	1.15	6.7	17.06	100.0
1981	1.33	8.3	4.27	26.6	9.49	59.1	0.96	6.0	16.05	100.0
1982	1.24	8.1	4.06	26.5	9.31	60.9	0.69	4.5	15.30	100.0
1983	1.29	8.5	3.86	25.3	9.40	61.7	0.68	4.5	15.23	100.0
1984	1.34	8.5	4.11	26.1	9.71	61.8	0.56	3.6	15.72	100.0
1985	1.35	8.6	4.03	25.6	9.87	62.7	0.48	3.1	15.73	100.0
1986	1.35	8.3	4.09	25.1	10.21	62.7	0.64	3.9	16.29	100.0
1987	1.37	8.2	4.26	25.6	10.49	62.9	0.55	3.3	16.6[illegible]	100.0
1988	1.41	8.2	4.37	25.3	10.82	62.6	0.68	3.9	17.28	100.0
1989	1.40	8.1	4.26	24.7	10.85	62.9	0.74	4.3	17.25	100.0

Source: Energy Information Administration

EXPORTS OF REFINED PRODUCTS AND CRUDE

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
					(1,000 b/d)					
Gasoline	1	2	20	10	6	10	33	35	22	39
Distillate	3	5	74	64	51	67	100	66	69	97
Residual	34	118	209	185	190	197	147	186	200	215
Lubricants	23	19	16	16	15	15	23	23	26	19
Coke	137	138	156	195	193	187	238	213	231	233
Asphalt and road oil	1	—	1	1	1	—	1	1	1	3
LPG	21	42	65	73	48	62	42	38	49	35
Other refined products	39	43	38	31	37	39	47	51	62	76
Total refined products	**259**	**367**	**579**	**575**	**541**	**577**	**631**	**613**	**660**	**717**
Crude	287	228	236	164	181	204	154	151	155	142
Total exports	**546**	**595**	**815**	**739**	**722**	**781**	**785**	**764**	**815**	**859**

Source: Energy Information Administration

tive years from 1942 to 1973. The only downturn of any duration had been during the great depression, when demand fell for three consecutive years between 1929 and 1932.

Following the price rise in 1973–74, demand for petroleum products fell 5.7%, from 17.308 million b/d to 1973 to 16.322 million b/d in 1975. When prices then leveled, demand resumed its increase, rising for three more years to peak at 18.847 million b/d in 1978. Over that three-year period, 1975–78, demand increased another 2.525 million b/d, 15.5%.

The second price hike put an end to the steady rise in demand for petroleum products. It had an almost immediate impact on demand. Demand fell 3.616 million b/d over the next five years to 15.231 million b/d in 1983. This was a drop of 19.2% and put demand back at the 1971 level, 12 years earlier. Price-induced conservation was the major reason for the decline, but sluggish economic activity also contributed to the drop in petroleum demand.

Demand for petroleum products increased in 1984 after five consecutive years of decline. Lower prices for petroleum products, and substantial economic growth, helped boost demand 3.2% in 1984 to 15.726 million b/d. Demand remained at this level in 1985 as economic growth slowed. The substantial drop in prices in 1986 stimulated petroleum product demand that year and it jumped up 3.5% to 16.281 million b/d. Product demand moved up another 2.4% to 16.665 million b/d in 1987. This was the highest level of demand since 1980. In 1988, low product prices again stimulated demand and it moved up 3.7%, to 17.283 million b/d. The increase slowed in 1989 but did increase 0.2%, to 17.325 million b/d, the highest level of demand in the 1980s.

In recent years, the trend in demand for petroleum products has been quite different for the various economic sectors. When prices moved up sharply from 1978 to 1981, demand fell in all sectors. But when prices started falling, demand reacted differently in the various sectors.

The sharpest decline has been in consumption by electric utilities. Since 1978, electric utilities have moved away from oil to coal and nuclear power. Demand dropped from 1.75 million b/d to 490,000 b/d in 1985, down 72%. The share of total petroleum demand fell from 9.3% to only 3.1%. Competition from nuclear power, coal and natural gas all reduced demand in this sector. In 1986, for the first time since 1978, consumption of petroleum products by electric utilities moved up. Because of the lower price, consumption jumped up 30.6%, to 640,000 b/d. This represented 3.9% of total petroleum product consumption. But with the increase in prices in 1987, demand slipped again to 550,000 b/d, 3.3% of total consumption. With lower prices again prevailing in 1988, electric utility consumption jumped again, to 680,000 b/d. It moved up again in 1989, to 731,000 b/d, even though prices were slightly higher. It appears that demand in this sector is

extremely sensitive to prices.

Industrial sector demand peaked in 1979 at about 5.34 million b/d. It fell to an estimated 3.85 million b/d in 1983, down 27.9%. It has moved back up in recent years to 4.37 million b/d in 1988 and 4.26 million b/d in 1989.

The industrial sector share of total domestic demand has not changed a great amount. It was 25.9% in 1973, moved up to 28.9% in 1979. It fell to 25.3% in 1983, but moved back up slightly to 25.4% in 1987, 25.3% in 1988, and 24.7% in 1989.

Residential and commercial sector demand was trending down from 1973 to 1982, dropping 44.4% from 2.23 million b/d to 1.24 million b/d in 1982. This sector's share of the total fell from 12.9% to 8.1%. Conversion to natural gas and the use of natural gas for new buildings because of the price advantage was the main reason for the downward shift. Demand in this sector has been on the rise, moving up to 1.37 million b/d in 1987, 1.41 million b/d in 1988, and 1.40 million b/d in 1989. This was 8.2% of total demand in 1987, 8.2% in 1988 and 8.1% in 1989.

Transportation sector demand had been on the rise since 1982, and the share of total demand has been constantly increasing since 1977. It passed the 1979 peak in 1986 and set an all time high in 1989 at 10.85 million b/d.

Transportation demand hit 10.16 million b/d in 1978, but then fell 8.4% to 9.31 million b/d in 1982. The major reasons for the decline were improved efficiency of motor vehicles, and cost consciousness and conservation by drivers.

Transportation demand has been increasing again since 1982, and in 1989 was up 16.5% from that recent low. The transportation sector's share of total petroleum demand has moved up from 52.9% in 1977 to 62.9% in 1987, 62.6% in 1988 and 62.9% in 1989. Lower gasoline prices, and the fact that petroleum products do not have major competition from other fuels in the transportation sector, have stimulated demand.

One of the things that was underestimated or ignored in some of the older forecasts was the price elasticity of demand for petroleum products; that is, the change in demand relative to a change in price. There is no way to isolate demand for petroleum products and measure only the response due to price change. But the sharp price hikes, particularly in the late 1970s, enable the calculation of a rough estimate of elasticity. Over the past few years, the elasticity of demand for all petroleum products has been approximately 0.1. For every 10% increase in the price, demand fell 1%. This varied from product to product.

Although this would indicate that demand was relatively "inelastic," it does show that, contrary to some past theories of ever-increasing petroleum demand, demand will fall if the price increase is too great.

From 1970 to 1981, the composite U.S. refiner acquisition cost of crude oil increased 936%, from $3.40/bbl to $35.24/bbl. This is an increase of $31.74/bbl and an average annual increase of 23%/year. Crude oil prices determine product prices, and therefore product prices also skyrocketed. These massive price increases, far surpassing the overall rate of inflation, had a tremendous impact on investment and consumption decisions and resulted in a reduction in demand for oil products.

The price of crude peaked in 1981 and fell for several years. The average composite U.S. refiner acquisition cost for 1984 was $28.63/bbl. This was a drop of 18.8% from the 1981 average price. Demand rebounded in 1984, increasing 3.2%. This is roughly a 1.7% increase in demand for every 10% decrease in price.

In 1985, the refiner acquisition cost fell an additional 6.5%, but demand remained at the same level as 1984. This would indicate an even lower elasticity of demand, closer to 1% change for every 10% shift in price. In 1986, the refiner composite acquisition cost of crude oil fell another 45.6%, to $14.55/bbl. In response, demand moved up 3.5%. In 1987, the refiner acquisition cost of crude moved up after declining for five consecu-

tive years. It increased to $17.91/bbl and demand still moved up, increasing 2.4%. In 1988, the refiner acquisition price slipped again, falling 17.8% and total demand jumped up 3.7%. In 1989 prices rebounded, increasing 22.5%, to $17.97/bbl. Petroleum demand was almost constant, increasing only 0.2%.

From 1981 through 1989, the cost of crude to the refiner is down 49%. Since hitting a low in 1983, demand in 1989 had increased 13.7%. Although this was a delayed response, it indicates approximately a 2.8% increase in demand for every 10% drop in price. These are very rough measures, but they do indicate a price elasticity that should be taken into account when projecting demand. However, it will take a longer period to determine if demand elasticity is close to this estimate.

The impact of price on motor gasoline demand has not been as great as for some other petroleum products, but it has been significant. Demand peaked in 1978 at 7.412 million b/d and then fell 11.8% to 6.539 million b/d in 1982.

The price of gasoline obviously influenced driving behavior, reducing the number of miles driven and changing attitudes about type of vehicles. Drivers cut out a lot of wasteful discretionary driving and also opted to purchase more fuel-efficient vehicles. A major result of the rapid increase in price was the federal government-mandated vehicle fuel efficiency standards. This forced improvement in vehicle fuel efficiency. Gasoline demand fell about 1% for every 10% increase in price during that period of decline. Over that period there was also a significant improvement in the fuel efficiency of the vehicle fleet.

As prices have been relatively low over the last few years, some of the conservation impact has diminished and motor gasoline demand has increased. The average pump price for motor gasoline fell below $1/gal for the first time since 1979, declining to 93.1 cts/gal in 1986. When adjusted for inflation, the average price of motor gasoline in 1986 was the lowest ever recorded. And motor gasoline demand responded, moving up 3% to the highest level since 1979, at 7.034 million b/d. This was only the fourth year on record where gasoline demand exceeded 7 million b/d.

Prices moved up only marginally in 1987 to 95.7 cts/gal. This low price level continued to stimulate demand, which moved up to 7.206 million b/d. The average pump price moved up only marginally again in 1988 to 96.3 cts/gal. Demand continued to increase to 7.336 million b/d. This was the second best year in history, surpassed only by the 7.412 million b/d in 1978. The average pump price moved up to $1.06/gal. in 1989 and demand leveled off at a slightly lower rate of 7.328 million b/d.

With the real, inflation-adjusted price at or near historical lows, individual discretionary conservation diminishes substantially. Motor gasoline demand of 7.328 million b/d in 1989 was up 12.1% since the recent low in 1982. The average pump price for all types of motor gasoline was down 21.7% from the peak of $1.353/gal in 1981. That would represent a 5.6% increase in demand for each 10% decline in price.

The level of demand for motor gasoline is affected by a number of competing factors: vehicle fuel efficiency, average miles driven per vehicle, and total number of vehicles in the fleet.

The total number of vehicles registered has been steadily increasing. It had reached 188.7 million in 1989, up 19.2% from 1981, the year of peak gasoline prices. Car registrations were 144.4 million, up 17.3%. Miles traveled per passenger car in 1988 was 10,119, up 10.2% from the 9,186 in 1981. Miles driven per car was at an all-time high of 10,521 in 1972.

These factors are offset by the improved vehicle efficiency and declining fuel consumption per vehicle. The average miles driven per gallon of gas consumed was 19.95 in 1988. This is up 25.2% since 1981, and up 50% from the low of 13.3 miles per gallon in 1973.

Highway and rail transport, and residential and commercial heating are the major uses for distillate. Demand for distillate fuel oil also peaked in 1978, at 3.432 million b/d. It then fell sharply, 22.2%, to 2.671 million b/d in 1982.

Between 1978 and 1981, the price of home heating oil increased 165.1% from 38.7cts/gal to $1.026/gal. This resulted in a shift to natural gas for heating, an increase in personal conservation and a sharp cut in fuel oil used. During the decline, distillate demand fell about 1.25% for every 10% increase in price.

Distillate prices have also been falling since 1981. As a result, the trend in distillate demand has been moving up since 1982. Demand moved up 18.2% from 1982 through 1989. Distillate demand moved up 1.6% in 1986 as prices fell sharply. It then moved up another 2.1% in 1987 and 4.9% in 1988 when prices softened again. Demand increased 1.1% in 1989 as prices moved up once more.

Highway diesel distillate demand is closely related to the level of economic activity. It has been increasing as the economy has expanded. This trend is expected to continue with diesel consumption moving up along with economic activity.

This increase in distillate demand has been partially offset by a decline in demand for home heating oil. Home heating oil has been losing share in the residential and commercial heating market to natural gas. As oil prices have declined, conversions to natural gas have slowed, but natural gas is still gaining market share. Natural gas or electric home heating are capturing a major share of new construction.

Changes in demand for residual fuel oil have accounted for a large share of the change in total petroleum product demand. Between 1978, the year of peak petroleum demand, and 1985, total petroleum product demand was down 3.121 million b/d. Residual fuel oil demand in 1985 was 1.202 million b/d, down 1.821 million b/d from the 1978 level. The drop in resid consumption was 58.3% of the decline in total petroleum consumption. Resid demand in 1985 was down 60.9% from the peak in 1977 of 3.071 million b/d.

The shift by electric utilities from residual fuel oil to cheaper fuel sources, such as coal, nuclear energy and hydro power, was the major reason for the drop in resid demand. In 1978, almost half of the resid consumed was by the utility sector, 48.3% or 1.461 million b/d. By 1985, utility sector demand had fallen 71%, to an estimated 424,000 b/d. Industrial demand was also down sharply, falling from 622,000 b/d in 1978 to an estimated 182,000 b/d in 1985.

The resid demand response to the price increases was a lot greater than for some other products. With more competition from competing fuels, resid demand tends to be more "elastic." Resid demand fell about 3% for every 10% increase in price.

One of the reasons that resid demand fluctuates so greatly is the fuel switching capability of U.S. consumers. It is estimated that there is fuel switching capability in place to reduce fuel oil consumption by 350,000–620,000 b/d by switching to other available fuels.

In 1986, demand jumped up 18%, an increase of 216,000 b/d. The much lower crude and resid prices enabled resid to recapture a portion of the industrial and utility demand for heavy fuel oil. The increase in resid demand accounted for 36.4% of the total increase in demand in 1986.

Resid demand slipped in 1987, falling to 1.264 million b/d, down 10.9%. Higher prices in 1987 decreased its competitive position in the electric utility and industrial sectors.

But falling prices again boosted demand for resid in 1988. Demand rebounded, increasing 114,000 b/d, 9%, to 1.378 million b/d. Electric utility consumption was up 24.5%, to 625,000 b/d. In 1989, resid demand slipped marginally to 1.37 million b/d. Resid prices were up 17.1%.

The long-range demand for resid will depend upon its competitive price compared to natural gas and coal. Projecting toward the end of and beyond the forecast period, the fuel source for

REAL PRICE OF GASOLINE

	Regular leaded gasoline price (ct/gal)	Real price* -(1967 $)
1919	25.47	49.12
1920	29.83	49.70
1921	26.31	49.11
1922	25.20	50.18
1923	21.97	43.02
1924	20.95	40.88
1925	22.20	42.26
1926	23.38	44.14
1927	21.09	40.54
1928	20.94	40.79
1929	21.42	41.73
1930	19.95	39.87
1931	16.98	37.26
1932	17.93	43.81
1933	17.82	45.95
1934	18.85	47.04
1935	18.84	45.84
1936	19.45	46.83
1937	19.99	46.50
1938	19.51	46.21
1939	18.75	45.05
1940	18.41	43.87
1941	19.23	43.60
1942	20.43	41.83
1943	20.53	39.60
1944	20.59	39.06
1945	20.50	38.02
1946	20.77	35.52
1947	23.11	34.55
1948	25.88	35.92
1949	26.79	37.54
1950	26.76	37.14
1951	27.15	34.89
1952	27.56	34.65
1953	28.69	35.80
1954	29.04	36.08
1955	29.07	36.24
1956	29.93	36.76
1957	30.96	36.74
1958	30.38	35.09
1959	30.49	34.94
1960	31.13	35.12
1961	30.76	34.33
1962	30.64	33.81
1963	30.42	33.16
1964	30.35	32.65
1965	31.15	32.96
1966	32.08	32.99
1967	33.16	33.16
1968	33.71	32.35
1969	34.84	31.73
1970	35.69	30.69
1971	36.43	30.03
1972	36.13	28.83
1973	38.82	29.17
1974	52.41	35.48
1975	57.22	35.50
1976	59.47	34.88
1977	63.07	34.75
1978	65.71	33.63
1979	87.79	40.38
1980	119.10	48.26
1981	131.10	48.15
1982	122.20	42.27
1983	115.70	38.77
1984	112.90	36.29
1985	111.50	34.61
1986	85.70	26.10
1987	89.70	26.35
1988	89.95	26.29
1989	99.80	27.83

*Average annual gasoline price deflated by consumer index.

growing electrical power demand is in doubt. There is little if any additional nuclear power capacity planned beyond the mid-1990s. Environmental concerns over acid rain are growing and this may put some temporary economic limitations on the growth of coal consumption. This may open up an opportunity for renewed demand for heavy fuel oil, to meet electric utility fuel requirements.

Other petroleum products demand has also been moving up over the past few years. Demand for jet fuel has moved up rapidly over the period 1982–89. Total demand for jet fuel has increased 47.5%, to 1.49 million b/d in 1989. The increase has been in demand for kerosene jet fuel for commercial aircraft. Deregulation in the airline industry has led to keen competition along with fare slashing. The ability to cut fares was assisted by lower fuel cost. The lower fares stimulated interest in travel by air. The result was a substantial increase in passenger traffic and a jump in jet fuel demand. This trend is expected to continue moving along with the growth in the economy.

Demand for all other products also moved up faster than total demand. This group includes petrochemical feedstocks, lubricants, still gas, waxes, asphalt, coke and others. Demand is expected to continue to move up. It will be driven by petrochemical demand, asphalt demand and lubricant demand. Asphalt demand is expected to be high for some time due to the need to repair and resurface the intrastate and interstate highways.

OUTLOOK

What happens in the future in the U.S. oil industry is closely tied to events in the worldwide industry. In fact, today the impact of any major event anywhere in the world that substantially affects supply in the industry is transferred immediately to the domestic industry via the pricing system and the futures exchanges.

The invasion of Kuwait by neighboring

Iraq in early August 1990 has had a substantial impact on the demand-supply relationship in the worldwide petroleum industry. These two countries together were producing around 4.7 million b/d at the time of the invasion. The subsequent embargo of crude oil from Iraq and Kuwait removed close to 4.2 million b/d in exports from these two nations. In addition, 300,000 b/d of production from the Kuwait share of the Neutral Zone was also affected by these events.

The sharp reduction in worldwide crude oil supply had an almost immediate impact on crude oil prices. Prices were on the rise before the invasion but moved up sharply after. The average price of world export crude oils increased 50% in the three weeks following the invasion. Prices on the futures market moved up over $30/bbl and hit the highest level since 1985.

There is no way to determine if the sharp rise in prices has had an immediate impact on demand for petroleum products. It is too soon after the invasion for any data on demand to be available. However, it is fairly safe to assume that an increase in oil prices of that magnitude will have a substantial impact on demand. And the impact will definitely be felt in the United States, the world's largest consumer of petroleum products. But the impact will go beyond the demand for petroleum products. If oil prices remain higher for an extended period, other energy costs will begin to move up as fuel substitution increases the demand for other fuels. The resulting increase in energy costs will have an impact on economic growth.

At this time it is uncertain how long the crisis involving Iraq and Kuwait will last. It is quite probable that the loss of that volume of crude oil will exert upward pressure on crude oil prices as long as the crisis continues. And it is almost impossible to estimate how long that will be. This makes it almost impossible to project with any certainty the most likely trend in economic growth, energy demand and demand for petroleum products.

Therefore, for the first time in this edition of the Oil Industry Outlook, three scenarios are being presented. The three scenarios vary in expectations of the length of time the crisis in the Persian Gulf will last. The length of time the oil crisis continues will have an impact on the price of crude oil, the cost of energy, the rate of economic growth, the level of energy consumption and the level of petroleum product demand. To cover these variations three separate forecasts are presented. The forecast with the highest degree of probability is the one that comes closest to the length of time it takes to finally resolve this issue in the Middle East, and for Iraqi and Kuwaiti oil to return to the market.

Scenario I—The situation in the Middle East lasts for an extended period. The embargo of oil exported from Iraq and Kuwait continues for a period of 6–18 months. The vast majority of oil production in Iraq and Kuwait is shut in for the duration of the dispute. Production and exports from the Kuwaiti half of the Neutral Zone are also curtailed during this period. Oil production capacity in other OPEC areas is not affected by the dispute. Following the settlement of the dispute, production in Iraq and Kuwait is resumed at levels close to the production levels prior to the invasion.

Scenario II—The situation in the Middle East lasts for an even longer time period than in Scenario I. The embargo of oil exported from Iraq and Kuwait continues for a period of 18–30 months. The vast majority of oil production in Iraq and Kuwait is shut in for the extended duration of the dispute. Production and exports from the Kuwaiti half of the Neutral Zone are also curtailed during this period. Oil production capacity in other OPEC areas is not affected by the dispute. Following the settlement of the dispute, production in Iraq and Kuwait is resumed at levels close to the production levels prior to the invasion.

Scenario III—The situation in the Middle East lasts for a relatively short period of time. The embargo of oil exported from Iraq and Kuwait continues for less than six months. The vast majority of oil production in Iraq and Kuwait is shut in

during this period. Production and exports from the Kuwaiti half of the Neutral Zone are also curtailed during this short period. Production capacity in other OPEC countries is not affected by this dispute. Following settlement of the dispute, production in Iraq and Kuwait is resumed at production levels close to those prior to the invasion.

The major differences between the three scenarios is the length of time that the crisis continues and Iraqi and Kuwaiti oil is off the market. But even though the length of time until settlement of the dispute is the only apparent difference, these three scenarios will cause three distinct sets of conditions in the oil market. And the different market conditions will create differing projections of demand for energy and petroleum products over the forecast period, 1991–95.

The disruption of oil production and oil exports from Iraq and Kuwait will have an immediate impact on crude oil and petroleum product prices. And it is expected that the loss of this oil will tighten the market and place upward pressure on prices while the crisis lasts. Prices will fluctuate with seasonal demand because requirements for OPEC oil will come close to capacity during the periods of peak demand. As demand approaches capacity, prices will be bid up by refiners and traders looking for supplies to meet winter demand.

With the elimination of supplies from Iraq and Kuwait, a substantial portion of the OPEC excess capacity has been eliminated. Therefore as long as that production remains shut in, the crude oil market will be tight, with little contingency production capacity available. Prices will remain much higher than they would be if Iraq and Kuwait production capacity was available to the market.

Although these events are taking place in the Middle East, they have an immediate effect on oil prices and through the price mechanism the impact is transferred to the United States. Therefore the loss to the market of the oil produced by Iraq and Kuwait will have an effect on the demand for energy and petroleum products in the U.S.

In the last few years the combination of lower oil prices, lower petroleum product prices and increased economic activity gave a boost to U.S. petroleum demand.

What should be kept in mind is that demand for energy and petroleum products is very dependent upon the level of economic activity and will tend to follow the trends in economic growth. But economic growth is also influenced by energy costs. The level of economic activity will still be one of the major factors determining the level of energy demand and petroleum product demand. But the cost of energy is the factor determining the effort given to conservation. And the relative price levels greatly influence the type of energy that will be used to fuel the economic growth. Economic growth, energy demand, oil demand, energy price, and oil prices are all interrelated and interdependent.

There are still a number of major problems that plague the worldwide and U.S. economy. Two of the major problems in the U.S. are the budget deficit and huge negative international trade balance. And there is a growing threat that a wave of protectionism may sweep over the U.S. and worldwide industrialized areas, reducing world trade. Any and all of these factors could slow U.S. economic growth.

These problems are being contained at the present time. And it is not anticipated that they will cause a recession during the next five years. However, the rapid rise in oil prices in 1990, and possibly continuing into 1991 and 1992, could substantially slow economic growth and even lead to a recession.

SCENARIO I—It is expected that the growth in U.S. economic activity will slow in 1990 and be lower than expected due to the higher oil prices. The annual rate of growth will slow even more in 1991, falling to around 1.1%, as oil and energy prices move up. With lower oil and energy prices in 1992, economic growth will rebound. U.S. economic activity is expected to increase at a rate ranging from 2.4–3.2%/year for

the remainder of the forecast period. GNP in 1995 is expected to be up 12.7% over the level in 1990.

SCENARIO II—In this scenario, U.S. economic activity will follow a pattern very similar to Scenario I through 1991. However, in 1992 as oil and energy prices continue to move up, the rate of growth in economic activity will remain at a low rate similar to 1991. It is quite possible that there could be a recession. When oil prices fall in 1993, there will be a rebound in the rate of growth for the worldwide economy. For the remainder of the forecast period it is expected that economic activity will grow at a rate similar to Scenario I, ranging from 2.4–3.1%/year. GNP in 1995 will be up 10.8% from the 1990 level.

SCENARIO III—In this scenario, high oil prices are expected to slow the rate of growth in 1990 and into the start of 1991. However, the rate of growth in 1991 will be higher than in Scenarios I and II. Since oil and energy prices are expected to return to lower levels in 1991, the rate of U.S. economic growth is expected to move up to 3.5% in 1992. For the remainder of the forecast period, economic growth under this scenario will average 2.5–2.8%/year. GNP in 1995 will be 14.2% above the level in 1990.

Once the dispute between Iraq and Kuwait is resolved, relatively low energy prices are expected to be a positive stimulus to economic activity throughout the remainder of the forecast period. Lower energy costs and lower interest rates should boost investment and productivity toward the end of the forecast period in all three scenarios. But potential growth will be moderate due to the overhanging burden of huge government, corporate and personal consumer debt. The economic growth rate will probably be slowed, as attention is diverted from productive activity to debt management. Looking at the long-term historical relationship of energy consumption to economic growth, it is expected that energy conservation will continue to some degree throughout the forecast period. Therefore the growth in energy demand will track the rate of growth of economic activity but at a slower rate. However, during the years of relatively low energy prices it is expected that the ratio of energy growth to economic growth will be greater than in the recent past. With low cost energy there is not as much incentive to invest in conservation. Instead, energy is used more liberally to fuel economic growth.

During the years of low-cost energy, investment in energy conservation will be lower than in past years, but it is still expected to continue to move up. There is now a great deal of concern about the impact of energy consumption on the environment. Therefore there will be a lot of pressure in the m United States and the rest of the world to improve on energy consumption efficiency.

SCENARIO I—Since growth in energy consumption will follow growth in economic activity, the pattern for the rate of energy growth will be similar to that outlined for economic growth. With higher oil and energy prices in 1991, economic growth will slow and the rate of increase in energy consumption will be lower. When oil prices fall in 1992, the rate of growth in economic activity will increase and so will the rate of growth in energy consumption. Total U.S. demand for energy is projected to be up 8.6% at the end of the forecast period, 1995.

SCENARIO II—In this scenario, energy consumption growth will also follow economic growth. Therefore energy demand growth will be quite modest in 1991 and 1992 due to the slower economic growth related to the sharp rise in oil and energy costs. The growth in energy demand will continue after the dispute is resolved and oil prices fall. However, since energy prices will remain high for a longer period of time, there will be greater investment in energy conservation. Therefore energy growth may not be as vigorous in the latter years of the forecast period as in the other two scenarios. U.S. energy demand is expected to be up 7.2% at the end of the forecast period, 1995.

SCENARIO III—In this scenario, energy consumption will also follow the expected rate of growth in economic activity. Growth will be slowed a bit in 1991 due to the higher oil and energy costs at the end of 1990 and possibly continuing into early 1991. Since oil and energy costs will revert to their former relatively low level, there will be little incentive for a substantial increase in investment in energy conservation. By the end of the forecast period, 1995, U.S. energy demand will be up 9.8% in this scenario.

Once the dispute is settled and energy costs decline, it is expected that energy consumption will move up at a faster rate relative to GNP than the average since 1970. Energy efficiency improvements could continue, but they will be offset by the increase in energy consumption to support economic growth. With the lower-cost energy, there will be less conservation and more energy consumption than with the higher prices.

The trend in the relationship of energy to real GNP will continue down the path of increased energy efficiency. Energy required per dollar of real GNP will drop under all three scenarios, from around 19,300 in 1990, down to 18,600 to 18,700 in 1995. This is a further improvement of 3.1–3.6% in energy efficiency.

The type and quantity of energy consumed will vary depending on the price levels in the three scenarios.

SCENARIO I—Consumption of energy from petroleum will move up 6.8% over the forecast period. Demand for petroleum will be slowed in 1991 due to the higher prices. Energy from coal will grow 10.4% over the forecast period, influenced most by demand for electricity. Energy from nuclear power will peak in 1993 at 6.2 quads. No additional nuclear facilities are being constructed. Over the forecast period nuclear's share will be up only 4%. Energy from hydroelectric power and other sources will increase 18.3% over the forecast period. More favorable weather conditions will enable hydropower to move up closer to its capacity. Natural gas will play the role of swing fuel source and displace some oil consumption during the period of high oil prices. As a cleaner and less environmentally damaging fuel, it may also displace coal in some instances. Consumption of natural gas energy will move up 9.5% over the forecast period.

SCENARIO II—Consumption of energy from petroleum will move up 5.9% over the forecast period. Demand for petroleum will be slowed in 1991 and 1992 due to the higher prices. Energy from coal will grow 10.4% over the forecast period, influenced most by increased demand for electricity. Energy from nuclear power will peak in 1993 at 6.2 quads. No additional nuclear facilities are being constructed. Over the forecast period, nuclear's share will be up only 4%. Energy from hydroelectric power and other sources will increase 18.3% over the forecast period. More favorable weather conditions will enable hydropower to move up closer to its capacity. Natural gas will play the role of swing fuel source and displace some oil consumption during the period of high oil prices. As a cleaner and less environmentally damaging fuel, it may also displace coal in some instances. Consumption of natural gas energy will move up 5.2% over the forecast period. The lower level of overall energy demand due to the lower rate of economic growth will have a substantial impact on the swing fuel source, natural gas

SCENARIO III—Consumption of energy from petroleum will move up 7.8% over the forecast period. Demand for petroleum will be slowed only in late 1990 and early 1991, due to the higher prices. Energy from coal will grow 9.9% over the forecast period, influenced most by demand for electricity. There will be some additional competition from low-cost heavy fuel oil. Energy from nuclear power will peak in 1993 at 6.2 quads. No additional nuclear facilities are being constructed. Over the forecast period nuclear's share will be up only 4%.

Energy from hydroelectric power and other sources will increase 18.3% over the forecast period. More favorable weather conditions will enable hydropower to move up closer to its capacity. Natural gas will play the role of swing fuel source and displace some oil consumption only during the brief period of high oil prices. As a cleaner and less environmentally damaging fuel, it may also displace coal in some instances. Consumption of natural gas energy will move up 13.3% over the forecast period. The higher level of total energy demand due to a higher rate of economic growth will be reflected in higher demand for natural gas, the swing fuel.

There are physical capacity limitations on the growth of nuclear and hydropower. And environmental limitations are being placed on coal consumption due to concerns about clean air and acid rain. This leaves only petroleum and natural gas to fill the additional energy demand. Therefore later in the forecast period the level of total energy demand will have an additional impact on demand for energy from petroleum and natural gas.

The petroleum share of the energy market will slip over the forecast period under all three scenarios from 41.6% in 1990 to a range of 40.8–41% in 1995. Change in the natural gas share of the market will vary widely under the three scenarios. Natural gas market share will increase from 23.6% in 1990 to 23.9% in 1995 under Scenario I. Under Scenario II the market share will fall to 23.2% in 1995. And under Scenario III it will increase to 24.4% of the total energy market in 1995.

Coal's share of the market will move up from 23.4% in 1990 to 23.8% in 1995 under Scenario I with the higher oil prices through 1991. Under Scenario II, with much higher oil prices in 1991 and 1992, coal's market share will move up to 24.1% in 1995. Under Scenario III, with low oil prices for most of the period, the market share will remain at 23.4%.

The share from nuclear power will fall from 7.3% in 1990 to 6.9–7.1% in 1995. Hydroelectric's and other source's share of the market will move from 4.1% in 1990 to 4.5–4.6% in 1995.

Petroleum and natural gas in combination will account for 64.2–65.2% of total energy needs in 1995. This will be down only slightly from 65.2% in 1990. It is obvious that these energy sources will be extremely important to the U.S. economy for the foreseeable future.

The energy market is expected to become more competitive toward the end of the forecast period. It is expected that the price/cost of competing fuels will continue to converge over the 1990–95 period.

Petroleum energy demand is made up of demand for a variety of individual petroleum products. Demand for each of these products is affected differently by the price level, the level of economic activity and the intensity of competition from other energy. Demand for all major types of petroleum products, including fuel oil, is expected to increase over the forecast period in all of the scenarios. One of the things that may stimulate demand for petroleum is the growth in electric power consumption in the United States. As the economy grows and shifts to a more information and- service-oriented economy, demand for electricity will move up. At the lower prices, fuel oil may play the role of swing fuel for electric utilities, and demand will increase.

SCENARIO I—Over the five-year forecast period, 1991–95, U.S. petroleum product demand is projected to increase 6.9%, to 18.37 million b/d in 1995. This is an increase of 1.18 million b/d. Demand will be slowed in 1991 due to higher oil prices. But after prices fall in 1992, demand is expected to move up more rapidly. Motor gasoline demand is expected to increase 2.4%, to 7.5 million b/d in 1995. Gasoline prices will be up sharply in 1991 and this will slow demand. After prices fall in 1992, demand will begin to expand again. An increase in the vehicle fleet and an increase in miles driven per

vehicle will offset the improvement in fuel efficiency. The rate of increase in fuel efficiency will slow as the older cars are scrapped. Demand for jet fuel will move up along with economic growth. In 1995, jet fuel consumption will be up 9.6% over the 1990 level at 1.655 million b/d. Distillate demand will also increase along with the growth in economic activity, moving up 7.7%, to 3.35 million b/d in 1995. The largest increase will be posted by residual fuel oil which is expected to increase 300,000 b/d, 24.5%, to 1.58 million b/d. Resid demand is expected to move up as a fuel source for generating electrical power. Nuclear power output is expected to peak and hydropower is limited by existing capacity. Some limitations will be placed on coal consumption because of environmental concerns. Resid and natural gas will be called on to fill the remaining gap.

SCENARIO II—Prices are expected to remain high throughout an extended period lasting through 1992. Demand will be slowed in 1991 and 1992 due to the higher oil prices. After prices fall in 1993, demand growth is expected to accelerate. Over the five-year forecast period, 1991–95, U.S. petroleum product demand is projected to increase 5.9% to 18.21 million b/d in 1995. This is an increase of 1.02 million b/d. Motor gasoline demand is expected to increase 1.6%, to 7.44 million b/d in 1995. Motor gasoline prices will be up sharply in 1991 and 1992 and this will slow demand. After prices fall in 1993, gasoline demand will begin to increase again. At that time an increase in the vehicle fleet and an increase in miles driven per vehicle will offset the improvement in fuel efficiency. The rate of increase in fuel efficiency will slow as the older cars are scrapped. Demand for jet fuel will move up along with economic growth. In 1995, jet fuel consumption will be up 9.3% over the 1990 level at 1.65 million b/d. Distillate demand will also increase along with the growth in economic activity, moving up 7.4%, to 3.34 million b/d in 1995. This is an increase of 230,000 b/d. Resid demand is also expected to move up 230,000 b/d over the forecast period. Residual fuel oil is projected to increase 18%, to 1.51 million b/d. Over the forecast period, resid demand is expected to move up as a fuel source for generating electrical power. Nuclear power output is expected to peak and hydropower is limited by existing capacity. Some limitations will be placed on coal consumption because of environmental concerns. Resid and natural gas will be called on to fill the remaining gap.

SCENARIO III—Under this scenario, prices will remain inflated for only a short period during late 1990 and possibly into early 1991. This will have only a minor impact on the growth in petroleum product demand. Over the five-year forecast period, 1991–95, U.S. petroleum product demand is projected to increase 7.8%, to 18.645 million b/d in 1995. This is an increase of 1.355 million b/d. Motor gasoline demand is expected to increase 3.5%, to 7.59 million b/d in 1995. Gasoline prices will be up sharply in late 1990 and early 1991 and this will slow demand but only for a short period of time. After prices fall in 1991, demand will begin to increase again. An increase in the vehicle fleet and an increase in miles driven per vehicle will offset the improvement in fuel efficiency. The rate of increase in fuel efficiency will slow as the older cars are scrapped. Demand for jet fuel will move up along with economic growth. In 1995, jet fuel consumption will be up 10.9% over the 1990 level at 1.68 million b/d. Distillate demand will also increase along with the growth in economic activity, moving up 7.7%, to 3.37 million b/d in 1995. The largest increase will be posted by residual fuel oil which is expected to increase 330,000 b/d, 25%, to 1.65 million b/d. Resid demand is expected to increase as a fuel source for generating electrical power. Nuclear power output is expected to peak and hydropower is limited by existing capacity. Some limitations will be placed on coal consumption because of environmental concerns. Resid and natural gas will be called on to fill the remaining gap.

In general, after the Middle East crisis is resolved and prices fall, the combination of lower oil prices and continued economic growth will stimulate total demand for petroleum products over the remainder of the forecast period. This will tend to boost demand for petroleum products. However, there is one factor that is holding back a major resurgence in oil demand, and that is the long-range price expectation. Since increased demand of any significant amount must be met by OPEC production, potential consumers are reluctant to commit to capital equipment that requires oil consumption. OPEC is not noted for exhibiting price restraint when the market conditions are in their favor. And the recent crisis has emphasized the vulnerability of depending upon oil from the Middle East. Major consumers have been preparing for any potential fuel price shock by obtaining multi-fuel capability. This will tend to keep prices of competing fuels close together and it will also help to exert some downward pressure on prices.

U.S. DEMAND KEYS TO THE FUTURE SCENARIO I

1. Economic expansion is projected to continue throughout the forecast period. The rate of growth will slow substantially in 1991, mainly due to the much higher energy costs that year. The rate of economic growth will move up markedly in 1992 when oil and energy prices fall in 1992. Growth will continue throughout the remainder of the forecast but at a rather slow pace. Inflation will not be a major problem but the rate will be up from the past few years. Overhanging government deficits, and company and consumer debt problems will probably slow the rate of growth.

2. The conflict in the Middle East will produce oil and energy prices during 1991 that are much higher than prices have been since 1986. Both domestic crude oil prices and petroleum product prices will be up substantially in 1991. It is likely that other energy prices will also be higher. Following the end of the dispute in 1992, energy and petroleum product prices will fall. Relatively low oil and energy prices will continue throughout the remainder of the forecast period. Prices will move up faster than the rate of inflation.

3. The much higher oil and energy prices in the first year of the forecast period will slow economic growth and energy consumption during the first part of the forecast period. When the oil and energy prices fall in 1992, economic growth will be stimulated and energy consumption will be boosted. The combination of continued economic growth and low energy prices will boost energy consumption throughout the remainder of the forecast period. There will be some increased incentive for conservation early in the forecast period. At that time, lower energy costs will again reduce the incentive for conservation. Energy efficiency will improve but the rate of improvement will be slowed. Technological breakthroughs with respect to more energy- efficient equipment and motors could have an impact by the end of the forecast period.

4. Demand for petroleum products will move up at a rate of growth close to that of total energy demand. Higher oil prices will slow demand in 1991. After prices fall, the lower prices will help stimulate consumption of petroleum products throughout the remainder of the forecast period. The level of total demand will be stimulated by the need for heavy fuel oil for electric power generation.

5. Demand for motor gasoline will fall in 1991 due to the much higher gasoline prices. When prices fall in 1992, gasoline demand will start to move up again. Demand will increase throughout the remainder of the forecast period, but at a very modest rate. Vehicle efficiency will continue to rise as the older cars are replaced. But the increased efficiency will be offset by increased miles driven and an increase in the number of vehicles. The increased population and, to some extent, increased affluence will boost the vehicle fleet substantially.

6. Continued economic expansion will result in increasing electric power consumption. Nuclear power output will hit a peak in 1993 or 1994. This will necessitate electric utilities turning to heavy fuel oil for some of the future power generation. Therefore demand for heavy fuel oil, resid, will move up over the forecast period.

7. In the future, environmental concerns will have an increasing and substantial impact on decisions concerning energy consumption. It is currently difficult to quantify the impact but it will probably lead to higher-cost energy. Environmental concerns will remain in the background over the period with high energy costs.

THE OUTLOOK — U.S. DEMAND
SCENARIO — I

	1989	1990	1991	1992	1993	1994	1995	Change 1990 to 1995	% change 1990 to 1995
ECONOMIC ACTIVITY									
Gross National Product (GNP) (billion 1982 dollars)	4,144	4,210	4,257	4,393	4,520	4,633	4,744	+ 534	+12.7
ENERGY DEMAND (trillion BTU)									
Petroleum	34,025	33,740	33,935	34,580	35,130	35,590	36,050	+2,310	+ 6.8
Natural gas	19,506	19,250	19,175	19,600	20,160	20,600	21,080	+1,830	+ 9.5
Coal	18,916	19,030	19,340	19,650	20,100	20,600	21,000	+1,970	+10.4
Nuclear	5,687	5,960	6,060	6,150	6,200	6,200	6,200	+240	+ 4.0
Hydro and other	3,106	3,380	3,500	3,750	3,900	3,950	4,000	+620	+18.3
Total	**81,240**	**81,360**	**82,010**	**83,730**	**85,490**	**86,940**	**88,330**	**+6,970**	**+ 8.6**
PETROLEUM DEMAND (thousand barrels/day)									
Motor gasoline	7,328	7,325	7,255	7,300	7,390	7,450	7,500	+175	+ 2.4
Jet fuel	1,489	1,510	1,550	1,585	1,605	1,625	1,655	+145	+ 9.6
Distillate fuel oil	3,157	3,110	3,200	3,235	3,265	3,295	3,350	+240	+ 7.7
Residual fuel oil	1,370	1,280	1,225	1,350	1,440	1,535	1,580	+300	+24.5
Ethane and LPG	1,668	1,605	1,640	1,700	1,720	1,740	1,760	+155	+ 9.7
Other products	2,313	2,360	2,420	2,450	2,480	2,490	2,525	+165	+ 7.0
Total	**17,325**	**17,190**	**17,290**	**17,620**	**17,900**	**18,135**	**18,370**	**+1,180**	**+ 6.9**
CRUDE OIL PRICE ($/barrel)									
U.S. average wellhead	15.85	19.05	23.80	18.60	19.55	20.50	21.50	+2.45	+12.9
West Texas intermediate (posted)	18.25	21.90	27.35	21.40	22.50	23.60	24.60	+2.70	+12.3
MOTOR GASOLINE PUMP PRICE (average all types) ($/gallon)	1.06	1.17	1.40	1.15	1.17	1.22	1.27	+0.10	+ 8.5

U.S. DEMAND
KEYS TO THE FUTURE
SCENARIO II

1. Economic expansion is projected to continue throughout the forecast period. The rate of growth will slow substantially in 1991 and 1992, mainly due to the much higher energy costs that year. The rate of economic growth will move up markedly in 1993 after oil and energy prices fall in 1993. Growth will continue throughout the remainder of the forecast but at a rather slow pace. Inflation will not be a major problem but the rate will be up from the past few years. Overhanging government deficits, and company and consumer debt problems will probably slow the rate of growth.

2. The conflict in the Middle East will produce oil and energy prices during 1991 and 1992 that are much higher than prices have been since 1986. Both domestic crude oil prices and petroleum product prices will be up substantially in 1991 and 1992. It is likely that other energy prices will also be higher. Following the end of the dispute in 1993, energy and petroleum product prices will fall. Relatively low oil and energy prices will continue throughout the remainder of the forecast period. Prices will move up faster than the rate of inflation.

3. The much higher oil and energy prices in the first two years of the forecast period will slow economic growth and energy consumption during the first part of the forecast period. When the oil and energy prices fall in 1993, economic growth will be stimulated and energy consumption will be boosted. The combination of continued economic growth and low energy prices will boost energy consumption throughout the remainder of the forecast period. There will be some increased incentive for conservation early in the forecast period. Some of the conservation investment will have a long-lasting impact on oil and energy demand. After oil prices fall, the lower energy costs will again reduce the incentive for conservation. Energy efficiency will improve more than under Scenario I, but the rate of improvement will be slowed after prices fall. Technological breakthroughs with respect to more energy-efficient equipment and motors could have a major impact by the end of the forecast period.

4. Demand for petroleum products will move up at a rate of growth close to that of total energy demand. Higher oil prices will slow petroleum product demand in 1991 and 1992. After prices fall in 1993, the lower prices will help stimulate consumption of petroleum products throughout the remainder of the forecast period. The level of total demand will be stimulated by the need for heavy fuel oil for electric power generation.

5. Demand for motor gasoline will fall in 1991 and 1992 due to the much higher gasoline prices. When prices fall in 1993, gasoline demand will start to increase again. Demand will increase throughout the remainder of the forecast period, but at a very modest rate. Vehicle efficiency will continue to rise as the older cars are replaced. But the increased efficiency will be offset by increased miles driven and an increase in the number of vehicles. The increased population and, to some extent, increased affluence will boost the vehicle fleet substantially.

6. Continued economic expansion will result in increasing electric power consumption throughout the forecast period. Nuclear power output will hit a peak in 1993 or 1994. This will necessitate electric utilities turning to heavy fuel oil for some of the future power generation. Therefore demand for heavy fuel oil, resid, will move up over the forecast period.

7. In the future, environmental concerns will have an increasing and substantial impact on decisions concerning energy consumption. It is currently difficult to quantify the impact but it will probably lead to higher-cost energy. Environmental concerns will remain in the background over the period with high energy costs.

THE OUTLOOK — U.S. DEMAND
SCENARIO — II

	1989	1990	1991	1992	1993	1994	1995	Change 1990 to 1995	% change 1990 to 1995
ECONOMIC ACTIVITY									
Gross National Product (GNP) (billion 1982 dollars)	4,144	4,210	4,257	4,303	4,437	4,552	4,666	+ 456	+10.8
ENERGY DEMAND									
(trillion BTU)									
Petroleum	34,025	33,740	33,935	34,170	34,760	35,250	35,740	+2,000	+ 5.9
Natural gas	19,506	19,250	19,175	18,860	19,440	19,830	20,260	+1,010	+ 5.2
Coal	18,916	19,030	19,340	19,650	20,100	20,600	21,000	+1,970	+10.4
Nuclear	5,687	5,900	6,060	6,150	6,200	6,200	6,200	+240	+ 4.0
Hydro and other	3,106	3,380	3,500	3,750	3,900	3,950	4,000	+620	+18.3
Total	**81,240**	**81,360**	**82,010**	**82,580**	**84,400**	**85,830**	**87,200**	**+5,840**	**+ 7.2**
PETROLEUM DEMAND									
(thousand barrels/day)									
Motor gasoline	7,328	7,325	7,255	7,230	7,330	7,380	7,440	+115	+ 1.6
Jet fuel	1,489	1,510	1,550	1,580	1,600	1,620	1,650	+140	+ 9.3
Distillate fuel oil	3,157	3,110	3,200	3,230	3,260	3,290	3,340	+230	+ 7.4
Residual fuel oil	1,370	1,280	1,225	1,230	1,330	1,450	1,510	+230	+18.0
Ethane and LPG	1,668	1,605	1,640	1,695	1,710	1,730	1,750	+145	+ 9.0
Other products	2,313	2,360	2,420	2,445	2,480	2,490	2,520	+160	+ 6.8
Total	**17,325**	**17,190**	**17,290**	**17,410**	**17,710**	**17,960**	**18,210**	**+1,020**	**+ 5.9**
CRUDE OIL PRICE									
($/barrel)									
U.S. average wellhead	15.85	19.05	23.80	26.20	18.10	19.50	20.90	+1.85	+ 9.7
West Texas intermediate (posted)	18.25	21.90	27.35	30.10	20.80	22.40	24.00	+2.10	+ 9.6
MOTOR GASOLINE PUMP PRICE									
(average all types) ($/gallon)	1.06	1.17	1.40	1.50	1.15	1.20	1.25	+0.08	+ 6.8

U.S. DEMAND

KEYS TO THE FUTURE

SCENARIO III

1. Economic expansion is projected to continue throughout the forecast period. The rate of growth will slow slightly in late 1990 and into early 1992, mainly due to the much higher energy costs over that period. Economic growth will continue throughout the remainder of the forecast but at a rather slow pace. Inflation will not be a major problem but the rate will be up from the past few years. Overhanging government deficits, and company and consumer debt problems will probably slow the rate of growth.

2. The conflict in the Middle East will produce oil and energy prices that are much higher for the end of 1990 and possibly into early 1991. But prices will not be up long enough to have any major extended impact. Both domestic crude oil prices and petroleum product prices will fall when the conflict is settled, probably by early 1991. Therefore, for the forecast period, oil and energy prices will be relatively low. Prices will continue to move up because of increased demand, but at a rate that is only slightly higher than the rate of inflation.

3. The modest oil and energy prices throughout the forecast period will help stimulate economic growth and boost energy consumption. There will be little increased incentive for energy conservation in the forecast period. Energy efficiency will improve, but the rate of improvement will be slow. Technological breakthroughs with respect to more energy-efficient equipment and motors could have an impact by the end of the forecast period.

4. Demand for petroleum products will move up at a rate of growth close to that of total energy demand. The relatively low oil prices will help stimulate consumption of petroleum products throughout the forecast period. The level of total demand will be stimulated by the need for heavy fuel oil for electric power generation.

5. Demand for motor gasoline will move up slowly throughout the forecast period. Gasoline prices will move up gradually over the five years. The increase in prices will not be sufficient to have much impact on demand. Vehicle efficiency will continue to rise as the older cars are replaced. But the increased efficiency will be offset by increased miles driven and an increase in the number of vehicles. The increased population and, to some extent, increased affluence will boost the vehicle fleet substantially.

6. Continued economic expansion will result in increasing electric power consumption. Nuclear power output will hit a peak in 1993 or 1994. This will necessitate electric utilities turning to heavy fuel oil for some of the future power generation. Therefore demand for heavy fuel oil, resid, will move up over the forecast period.

7. In the future, environmental concerns will have an increasing and substantial impact on decisions concerning energy consumption. It is currently difficult to quantify the impact but it will probably lead to higher-cost energy.

THE OUTLOOK — U.S. DEMAND
SCENARIO — III

	1989	1990	1991	1992	1993	1994	1995	Change 1990 to 1995	% change 1990 to 1995
ECONOMIC ACTIVITY									
Gross National Product (GNP) (billion 1982 dollars)	4,144	4,227	4,316	4,467	4,592	4,711	4,829	+ 602	+14.2
ENERGY DEMAND (trillion BTU)									
Petroleum	34,025	33,940	34,380	35,065	35,595	36,085	36,595	+2,655	+ 7.8
Natural gas	19,506	19,300	19,620	20,205	20,805	21,325	21,865	+2,565	+13.3
Coal	18,916	19,110	19,350	19,650	20,100	20,600	21,000	+1,890	+ 9.9
Nuclear	5,687	5,960	6,060	6,150	6,200	6,200	6,200	+240	+ 4.0
Hydro and other	3,106	3,380	3,500	3,750	3,900	3,950	4,000	+620	+18.3
Total	**81,240**	**81,690**	**82,910**	**84,820**	**86,600**	**88,160**	**89,660**	**+7,790**	**+ 9.8**
PETROLEUM DEMAND (thousand barrels/day)									
Motor gasoline	7,328	7,335	7,340	7,430	7,490	7,550	7,590	+255	+ 3.5
Jet fuel	1,489	1,515	1,555	1,575	1,595	1,635	1,680	+165	+10.9
Distillate fuel oil	3,157	3,130	3,210	3,245	3,265	3,305	3,370	+240	+ 7.7
Residual fuel oil	1,370	1,320	1,350	1,440	1,545	1,600	1,650	+330	+25.0
Ethane and LPG	1,668	1,610	1,645	1,705	1,755	1,795	1,830	+220	+13.7
Other products	2,313	2,380	2,430	2,460	2,485	2,500	2,525	+145	+ 6.1
Total	**17,325**	**17,290**	**17,530**	**17,855**	**18,135**	**18,385**	**18,645**	**+1,355**	**+ 7.8**
CRUDE OIL PRICE ($/barrel)									
U.S. average wellhead	15.85	18.55	17.15	19.05	20.00	21.00	22.00	+3.45	+18.6
West Texas intermediate (posted)	18.25	21.35	19.75	21.90	23.00	24.15	25.30	+3.95	+18.5
MOTOR GASOLINE PUMP PRICE (average all types) ($/gallon)	1.06	1.15	1.10	1.15	1.20	1.25	1.30	+0.15	+13.0

U.S. OUTLOOK—SUPPLY

The upheaval in the oil market, because of the dispute between Iraq and Kuwait, will undoubtedly have an impact on the U.S. supply situation. The United States is the world's largest consumer of petroleum products. And the United States now imports close to 50% of its oil supply. Therefore anything that upsets the world oil market is felt in the United States.

What may not be immediately obvious is that the dispute in the

U.S. LIQUIDS PRODUCTION AND RESERVES

	1973	1975	1977	1979	1981	1982	1983	1984	1985	1986	1987	1988	1989	% change 89/79	% change 89/73
	(1,000 b/d)														
Crude & condensate production:															
California	921	883	958	966	1,055	1,100	1,109	1,126	1,161	1,114	1,084	1,054	998	3.3	8.4
Kansas	181	162	158	156	180	193	196	207	207	184	164	161	152	-2.6	-16.0
Louisiana	2,278	1,796	1,542	1,355	1,231	1,256	1,314	1,408	1,392	1,403	1,320	1,217	1,109	-18.2	-51.3
New Mexico	276	259	239	217	196	195	206	217	215	207	198	195	188	-13.4	-31.9
North Dakota	55	56	64	84	124	130	139	144	139	125	113	107	101	20.2	83.6
Oklahoma	524	447	428	393	422	435	435	460	446	409	368	352	322	-18.1	-38.5
Texas	3,546	3,347	3,117	2,776	2,589	2,535	2,473	2,472	2,435	2,300	2,137	2,062	1,960	-29.4	-44.7
Wyoming	389	349	306	361	358	324	324	340	352	332	316	311	295	-18.3	-24.2
Others	839	872	904	843	808	785	778	783	799	739	687	664	614	-27.2	-26.8
Total Lower 48	**9,009**	**8,171**	**7,716**	**7,151**	**6,963**	**6,953**	**6,974**	**7,157**	**7,146**	**6,813**	**6,387**	**6,123**	**5,739**	**-19.7**	**-36.3**
Alaska	199	191	463	1,402	1,609	1,696	1,714	1,722	1,825	1,867	1,962	2,017	1,874	33.7	841.7
Total U.S.	**9,208**	**8,362**	**8,179**	**8,553**	**8,572**	**8,649**	**8,688**	**8,879**	**8,971**	**8,680**	**8,349**	**8,140**	**7,613**	**-11.0**	**-17.3**
NGL production:															
Total U.S.	1,738	1,633	1,618	1,584	1,609	1,550	1,559	1,630	1,609	1,551	1,595	1,625	1,546	-2.4	-11.0
Total liquids production:															
Total U.S.	10,946	9,995	9,797	10,137	10,181	10,199	10,247	10,509	10,580	10,231	9,944	8,765	9,159	-9.6	-16.3
	(Million bbl)														
Total U.S. Reserves															
Crude	35,299	32,682	29,486	27,051	29,426	27,858	27,735	28,446	28,416	26,889	27,256	26,825	26,501	-2.0	-24.9
NGL	6,455	6,268	5,994	5,655	7,068	7,221	7,901	7,643	7,944	8,165	8,147	8,238	7,769	37.4	20.4
Total	**41,754**	**38,950**	**35,480**	**32,706**	**36,494**	**35,079**	**35,636**	**36,089**	**36,360**	**35,054**	**35,403**	**35,063**	**34,270**	**4.8**	**-17.9**
	(Years)														
Reserves/production ratio:															
Crude	10.50	10.71	9.88	8.67	9.40	8.82	8.75	8.75	9.00	8.49	8.94	9.00	9.51		
NGL	10.18	10.52	10.15	9.78	12.04	12.76	13.89	12.81	13.85	14.42	13.99	13.85	13.73		
Total	**10.45**	**10.68**	**9.92**	**8.84**	**9.82**	**9.42**	**9.53**	**9.38**	**9.81**	**9.39**	**9.75**	**9.81**	**10.22**		

Source: American Petroleum Institute; Energy Information Administration

Middle East will also have an impact on U.S. domestic production. The impact will be transferred via the price structure for crude oil. If the worldwide price for crude oil moves up, then the price for U.S.-produced crude oil will follow.

Most of the production in the United States is considered high-cost compared to production in many other areas. Therefore the current level of crude oil and natural gas prices have a substantial impact on the domestic supply outlook for the United States. Lower prices, such as these the industry has experienced from 1986 through the first half of 1990, stimulate demand but also tend to depress output, particularly in the higher-cost production areas like the United States. But the high prices that came with the loss of crude oil from Iraq and Kuwait could stimulate additional exploration and production.

Crude oil production in the United States is not demand-constrained as is OPEC output. There is no excess capacity problem in the United States. There is no problem finding a market for domestic crude production. The United States is not self-sufficient in crude oil and therefore has been importing crude oil and products for a long time.

The availability of U.S. domestic crude oil is related to the worldwide price of crude oil and the current domestic cost of production. A substantial volume of U.S. production is relatively high-cost production. And high-cost production volume is much more sensitive to any significant change in price. This is not the case for production in some of the prolific low-cost areas such as the Middle East.

The recent high price era, 1980–85, stimulated U.S. production. At those price levels, U.S. production actually started to move back up after several years of decline. Capital investment flowed into the industry, activity hit record highs,

new reserves were found and output moved higher.

But that trend changed abruptly in 1986 when crude prices plummeted. Particularly in the U.S. lower-48, maintaining production was dependent upon drilling thousands of new wells. At the lower 1986 price level, much of the drilling activity became uneconomic. In addition to the curtailment of new exploration, many marginal producing wells were considered uneconomic and were shut in. The end result was the start of a slide in U.S. production that has continued through 1989 and into 1990. The slide was accelerated in 1989 as Alaskan North Slope production peaked and started down.

In the past, the supply response to price changes had been relatively slow. But this was the only time in recent years that there had been a price drop of this magnitude. And the response was a definite and significant decline in U.S. output. This may change with the higher prices but it is difficult to estimate how long those prices will remain inflated.

In the long run, domestic demand for petroleum products can be met by domestic production and/or imports of crude oil and products. Since U.S. domestic production is unable to support total domestic demand for petroleum products, a substantial and growing volume of imports is required. Imports are the swing supply source, and vary with demand. Recently the picture has been rather clear. With increasing demand and declining production, increased imports were required to fill the widening gap between domestic demand and domestic supply.

In the short run, crude and product stocks can help to satisfy demand, but only temporarily. Stocks have already been cut close to minimum operating requirements and therefore will not provide a major source of supply over the forecast period. And in periods of uncertainty it is unlikely that refiners will cut inventories. It is more likely that they will retain a comfortable level of stocks in case of a supply disruption.

REVIEW

TOTAL LIQUIDS PRODUCTION. Crude and condensate production has been sliding in the United States since the early part of 1986. The downward slide has continued from early 1986 into 1990 and expectations are that it will continue for the foreseeable future. The precipitous drop in the wellhead price of U.S. crude oil in 1986 was the major reason the slide started. Even though prices rebounded somewhat in 1987, the increase was not sufficient to stop the decrease in U.S. production. Prices slipped again in 1988 and the decline actually began to accelerate. A subsequent price rise in 1989 did nothing to slow the decline.

U.S. crude and condensate production declined from 9.477 million b/d in 1972 to 8.132 million b/d in 1976, a drop of 1.345 million b/d, or 14.2%. With the development of the Alaskan North Slope, production jumped to 8.707 million b/d in 1978. But the decline in lower-48 production pulled the total down again in 1979 as total U.S. production fell to 8.552 million b/d.

This downward slide stopped in 1979 and was reversed by the drilling boom of 1980–82. High domestic crude prices resulting from the OPEC price increase of 1979–81 stimulated domestic exploration and development. At these higher prices, production from marginal low-volume U.S. wells became profitable. Drilling activity increased markedly because of the increased profitability of smaller discoveries.

Initially the drilling boom arrested the decline and U.S. production remained fairly constant, at 8.597 million b/d in 1980 and 8.572 million b/d in 1981. But over the next four years the increase in exploration and drilling actually resulted in an increase in production. The substantial accumulation of new producing wells in the lower-48, coupled with increased Alaskan output, boosted total production to 8.971 million b/d in 1985. The higher prices and corresponding increasing in drilling activity helped push up U.S.

production 399,000 b/d, up 4.7%.

The price of crude oil had been the determining factor in increasing production. Prior to that period, the almost unanimous expectations were for declining U.S. production, particularly in the lower-48 states. This rapid increase in prices stimulated domestic exploration and drilling, and encouraged the development of previously uneconomical reserves. The drilling and development surge over the 1979–82 period helped slow the expected decline rate in the lower-48 states. In fact, lower-48 output actually moved up over the 1981–85 period.

Prior to the drilling boom, the decline in lower-48 production had been somewhat masked by increased Alaskan production. Lower-48 production fell from 9.275 b/d in 1972 to 6.953 million b/d in 1982, a drop of 2.322 million b/d, down 25%.

Effects of the drilling boom began to show up in 1983, as lower-48 output moved up marginally to 6.974 million b/d. This was an increase of 21,000 b/d; only 0.3%, but a complete reversal of the expected constant rate of decline. Lower-48 production continued to move up in 1984 with output increased to 7.157 million b/d. Production in 1985 was sustained at close to this level with 7.146 million b/d.

Sliding prices slowed drilling activity from 1983 to 1985. But the sharp drop in prices in 1986 led to a drop in drilling activity to the lowest level ever recorded. Coupled with the shutting in of marginal wells, this led to a drop in lower-48 production of 333,000 b/d, 4.7%, to 6.813 million b/d for 1986.

Production continued to slide in 1987 even though there was a slight increase in prices. Lower-48 output fell an additional 426,000 b/d to 6.387 million b/d. Alaskan production increased 95,000 b/d in 1987, so total U.S. output was down only 331,000 b/d. Lower-48 production continued to drop during 1988. It averaged 6.123 million b/d, down another 264,000 b/d. The slide continued in 1989. Lower-48 production fell to 5.739 million b/d, down another 384,000 b/d, a drop of 6.3%. This is the lowest level of lower-48 output since 1950.

Since the recent drilling boom high of 7.157 million b/d in 1984, lower-48 output has fallen 1.418 million b/d, 19.8% in five years. Until 1989, part of the decline in lower-48 output had been offset by increasing Alaskan production.

The Alaskan North Slope was developed in 1977 and 1978. The first full year of North Slope production, 1978, Alaskan output was 1.229 million b/d. Production from the North Slope moved up steadily through 1988. Alaskan production in 1988 reached 2.017 million b/d. Production in 1988 was up 295,000 b/d since 1984, and offset 28.5% of the drop in lower-48 output.

But this changed in 1989. Lower prices curtailed some exploration plans in Alaska. Concern over the environmental impact, particularly after the Valdez tanker accident, also slowed production and future development plans. This allowed the natural decline to take over on the North Slope and Alaskan production fell for the first time in 1989. Output for the year fell 143,000 b/d to 1.874 million b/d.

If future development plans are delayed substantially, then Alaskan production could fall more rapidly in the future. This will result in a much faster decline rate for total U.S. output of crude oil.

Also contributing to total liquids output is NGL production. NGL production has not varied greatly over the past several years. Output varies with the relative economics associated with gas liquids products. It is dependent upon the cost of extraction versus the market value of the products. Producers have the flexibility of varying the extraction rate of liquids from gas, dependent upon the economics.

From 1975 to 1980, NGL output averaged 1.596 million b/d. Over the next five years, 1981–85, output averaged 1.591 million b/d. Output hit a low of 1.55 million b/d in 1982, but was up to 1.63 million b/d in 1984 and 1.609 million

CRUDE AND PRODUCT IMPORTS: RELATION TO DEMAND

	1973	1977	1978	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	% change 78/73	% change 89/73
	(1,000 b/d)														
Imports:															
Crude*	3,244	6,594	6,195	5,219	4,141	3,323	3,096	3,229	3,083	4,130	4,601	5,056	5,787	+ 91.0	+78.4
Products	3,012	2,193	2,008	1,646	1,599	1,625	1,722	2,011	1,866	2,045	2,004	2,295	2,217	− 33.3	−26.4
Total	**6,256**	**8,787**	**8,203**	**6,865**	**5,740**	**4,948**	**4,818**	**5,240**	**4,949**	**6,175**	**6,605**	**7,351**	**8,004**	**+ 31.1**	**+27.9**
Domestic demand	17,308	18,431	18,847	17,056	16,058	15,296	15,231	15,726	15,726	16,281	16,665	17,283	17,325	+ 8.9	+ 0.1
Dependency ratio: Imports/demand	36.2	47.7	43.5	40.3	35.8	32.4	31.6	33.3	31.5	37.9	39.6	42.5	46.2		

* Excludes imports for Strategic Petroleum Reserve.
Source: Energy Information Administration

b/d in 1985. As a result of lower prices, NGL production fell sharply in 1986, to 1.551 million b/d. Output rebounded in 1987, to 1.595 million b/d, and then moved up to 1.625 million b/d in 1988. Output fell to 1.546 million b/d in 1989. This was the lowest level of NGL production since 1968.

Total liquids production, crude and condensate plus NGL, was 10.008 million b/d in 1987. This was down 546,000 b/d, 5.4% since 1984. Total liquids production for 1988 was 9.818 million b/d, down 736,000 b/d, 7% since 1984. This was the first time since 1977 that total liquids production had fallen below 10 million b/d, and only the third year since 1967. Total liquids output for the United States fell another 599,000 b/d, 6.1%, in 1989, to 9.219 million b/d. This was the lowest level since 1965.

RESERVES. The level of oil reserves and the ratio of proven reserves to current production are key indicators of future production potential.

Total U.S. crude oil reserves fell sharply from 1970 through 1979. Reserves were at a peak in 1970 at 39 billion barrels due to the addition of Prudhoe Bay in Alaska. By 1979, estimated reserves had slipped to 27.1 billion barrels, down 30.6%.

The drilling boom in the United States from 1979 to 1982 that followed the sharp increase in prices first slowed the decline in U.S. reserves and then temporarily reversed the long-run decline. Reserves moved back up and were 28.4 billion barrels in 1985.

But the sharp drop in prices in 1986 also took its toll on crude reserves. Estimated reserves fell 5.4%, to 26.9 billion barrels. This moved back up in 1987, to 27.3 billion barrels. The increase was due to a large revision rather than increased exploration. The reserve estimate fell another 1.6%, to 26.825 billion barrels in 1988. The record low level of drilling activity was the major reason for the continued decline.

The reserves/production ratio is a good indicator of potential future production. In 1970, the year of peak U.S. reserves, the ratio was 11.09 years. The ratio slipped to 10.68 years in 1975 and then slipped sharply to 8.84 years in 1979 just before the large drilling boom.

The ratio jumped to 9.84 years in 1980 and 9.82 years in 1981, along with the increased drilling activity. The ratio slipped to 9.42 years by 1985. It then slipped in 1986 to 8.5 years, an historic low for this ratio. It moved up slightly in 1987, to 8.9 years, and in 1988, to 9 years. Production slipped faster than reserves between 1986 and 1988, causing the increase in the ratio.

These low ratios should serve as a signal that action should be taken to stimulate exploration activity. Replacing reserves is essential to the long-term viability of the U.S. domestic industry and to U.S. energy security. And it is apparent that a massive exploration and drilling effort is essential to accomplish a turnaround in the reserves estimates.

IMPORTS. To fill the growing gap between declining U.S. petroleum production and increasing U.S. demand for petroleum products, imports have been rising rapidly in recent years. The role of crude oil and petroleum product imports in U.S. supply is increasing rapidly. U.S. domestic liquids production is not sufficient to meet U.S. demand. Therefore, imports are essential to fill the gap between domestic demand and domestic production.

Imports are the swing source of petroleum and vary with the magnitude of the gap between domestic demand and domestic production. Since domestic demand is moving up, and domestic production is on the decline, that gap is widening and imports are on the rise. Imports are rapidly reaching a level equal to half of U.S. supply.

It should be noted here that the imports of concern are industry imports. Imports for the Strategic Petroleum Reserve (SPR) are not included in this analysis. They are more of a national security issue at this point. Until their role in meeting supply need is better defined, the SPR reserves are not a factor in the demand-supply equation. What is needed is a sound mechanism or policy that clearly defines the way the SPR reserves will be used in an emergency situation. Without that mechanism, their use becomes a political issue. An efficient mechanism for their use in balancing the market and dampening price swings would require some provision for immediate response. By the time a political debate is completed, the market will have reacted to the emergency.

After a long period of rising U.S. imports, total U. S. imports peaked in 1977 at 8.787 million b/d. This was during the era of rapidly rising demand. As demand fell, following the huge increase in prices, imports were reduced. Demand fell 3.616 million b/d over the period 1978 through 1983. This decline in demand resulted in a drop in imports. Imports fell to 4.818 million b/d in 1983, down 3.969 million b/d, 45.2%. Imports absorbed the entire drop in U.S. demand.

SPOT MARKET VOLUMES

	U.S. Imports (Thousand barrels per day)		
Year	Total industry imports	Fixed price contract	Spot market
1975	6,056	5,871	185
1976	7,313	7,018	295
1977	8,786	8,346	440
1978	8,201	7,751	450
1979	8,389	7,884	505
1980	6,866	6,386	480
1981	5,740	5,165	575
1982	4,948	3,958	990
1983	4,817	2,887	1,930
1984	5,240	2,358	2,882
1985	4,949	985	3,964
1986	6,176	620	5,556
1987	6,605	660	5,945
1988	7,351	730	6,621
1989	8,005	715	7,290

Note: Spot market volumes include for 1983 and 1984 contract volumes where the price is directly related to spot market prices and fluctuates with the spot market prices. This might be more aptly labeled "volumes traded on the spot market and at market related prices."

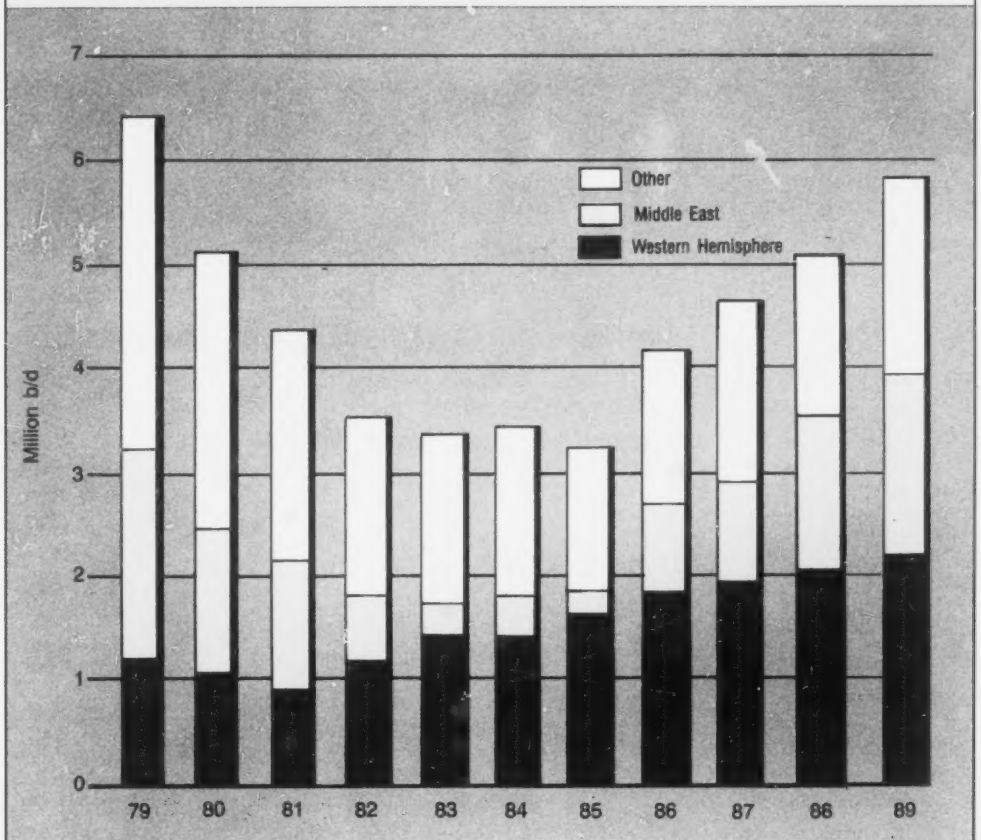
Source: Energy Information Administration and Author's estimates

In addition, increased domestic production and stock adjustments backed out an additional 353,000 b/d in imports.

As demand began to rise again, total imports moved up in 1984 to 5.24 million b/d. But they slipped again in 1985 to 4.949 million b/d. Increased domestic production and a drop in crude and product stocks in 1985 enabled a reduction in imports. But by year end 1985, stocks had been drawn down close to minimum levels. After that, any increase in demand would have to be met by increased imports.

Imports jumped up sharply in 1986 as demand increased and domestic production fell. Total imports increased 24.8% in 1986 to 6.175 million b/d. This was the highest volume of imports since 1980. Imports continued to climb in 1987, filling in the growing gap between slumping U.S. production and increased demand for petroleum products. Imports moved up another 7%, to 6.605 million b/d. This continued through 1989 as U.S. demand continued to increase and domestic production continued to slide. Total imports moved up another 1.4 million b/d, to 8.805 million b/d in 1989. Imports in 1989 were

CRUDE OIL IMPORTS*



*Includes imported crude for the Strategic Petroleum Reserve.
Source: Energy Information Administration

up 66.2% from 1983. This is an increase of 3.188 million b/d. Imports in 1989 moved up over 8 million b/d for the first time since 1979. And this was the fourth highest year on record.

The largest swings have been in imports of crude oil rather than petroleum product imports. Most of the decline which occurred in the years 1977–83 was in crude oil imports, which fell 3.498 million b/d, from 6.594 million b/d in 1977 to 3.096 million b/d in 1983, a drop of 53%. Product imports fell 471,000 b/d, 21.5%, from 2.193 million b/d to 1.722 million b/d in 1983.

Crude imports jumped up in 1984 to 3.229 million b/d but then fell again in 1985 to 3.083 million b/d. The decline in 1985 was due to increased domestic production and destocking. Crude imports jumped 34% in 1986 to 4.178 million b/d. The drop in domestic production, coupled

CRUDE IMPORTS BY COUNTRY OF ORIGIN

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
						(1,000 b/d)					
Eastern Hemisphere:											
Algeria	608	457	261	90	176	194	84	79	115	58	60
Angola	39	37	45	42	71	85	104	102	180	203	279
Egypt	55	31	33	40	25	10	3	10	54	26	15
Gabon	42	25	35	40	59	57	51	25	35	15	49
Libya	642	549	317	23	—	—	—	—	—	—	
Nigeria	1,069	843	611	510	301	207	280	437	529	607	800
Other Africa*	42	62	32	30	48	65	62	89	84	102	83
Total Africa	**2,497**	**2,004**	**1,334**	**775**	**680**	**618**	**584**	**741**	**997**	**1,011**	**1,287**
Kuwait	5	27	—	2	7	24	4	28	70	80	155
Oman	37	24	24	22	34	10	2	8	35	7	18
Qatar	31	22	7	7	—	4	—	12	—	—	2
Saudi Arabia	1,347	1,254	1,112	530	321	309	132	618	642	902	1,116
United Arab Emirates	281	173	77	81	18	90	35	38	56	23	21
Other Middle East*	395	38	6	38	58	23	72	100	182	389	451
Total Middle East	**2,096**	**1,538**	**1,226**	**680**	**438**	**460**	**245**	**804**	**985**	**1,401**	**1,762**
Indonesia	380	315	318	226	315	304	292	297	262	186	158
Malaysia	55	61	33	18	3	—	1	11	12	19	39
Other Far East*	—	1	—	11	7	40	56	80	127	154	137
Total Far East	**435**	**377**	**351**	**255**	**325**	**344**	**349**	**388**	**401**	**359**	**333**
Norway	75	144	114	102	65	112	31	53	70	62	127
United Kingdom	197	174	369	441	365	378	278	317	304	254	160
Other Europe*	8	—	—	—	3	3	1	9	1	5	3
Total Europe	**280**	**318**	**483**	**543**	**433**	**493**	**310**	**379**	**375**	**321**	**290**
Other Eastern Hemisphere†	3	—	37	54	91	120	53	30	—	—	29
Total Eastern Hemisphere	**5,311**	**4,237**	**3,431**	**2,307**	**1,967**	**2,035**	**1,541**	**2,342**	**2,758**	**3,091**	**3,701**
Western Hemisphere:											
Brazil	—	1	14	19	2	—	—	—	—	—	—
Ecuador	30	17	38	22	56	47	56	64	23	33	80
Mexico	436	508	469	645	766	658	715	621	602	674	716
Peru	40	41	30	21	8	1	12	9	1	5	1
Trinidad-Tobago	—	115	102	92	83	87	98	93	75	71	73
Venezuela	293	156	147	155	164	253	305	416	488	439	495
Other Latin America*	—	3	—	—	4	1	—	63	119	112	147
Total Latin America	**799**	**841**	**800**	**964**	**1,083**	**1,047**	**1,186**	**1,266**	**1,308**	**1,335**	**1,512**
Canada	271	200	164	214	274	341	468	570	608	681	630
Other Western Hemisphere†	124	—	1	3	5	3	6	—	—	—	
Total Western Hemisphere	**1,194**	**1,041**	**965**	**1,181**	**1,362**	**1,391**	**1,660**	**1,836**	**1,916**	**2,015**	**2,142**
Total Crude Imports	6,505	5,278	4,396	3,488	3,329	3,426	3,201	4,178	4,674	5,107	5,843
Less: SPR Imports	67	44	256	165	234	197	118	48	73	51	56
Crude Imports (ex. SPR)	6,438	5,234	4,140	3,323	3,095	3,229	3,083	4,130	4,601	5,056	5,787
OPEC Imports	5,112	3,864	2,922	1,734	1,477	1,512	1,312	2,113	2,400	2,626	3,376
% OPEC Imports	78.6%	73.2%	66.5%	49.7%	44.4%	44.1%	41.0%	50.6%	51.4%	52.8%	57.8%

*May include data on countries listed specifically but for which no individual data are reported.
†Includes data which could not be broken down by country or continent.
Source: Energy Information Administration

with the increase in demand, led to the need for more imported crude oil. In addition, refiners took advantage of the low-priced crude market to boost crude stocks 3.1%.

Crude imports continued to move up in 1987, reaching 4.601 million b/d. In 1988, crude imports jumped up another 9.9%, to 5.055 million b/d. Imports for 1989 continued this trend,

increasing another 731,000 b/d, 14.5%, to 5.787 million b/d. It also is the highest level since 1979, and is surpassed only by the crude import levels in the 1977–79 period. The peak year for imports was 1977, at 6.594 million b/d.

The movement in product imports has not been as volatile, but it has followed a similar pattern. Product imports hit bottom in 1981, at 1.599 million b/d. They then moved up substantially between 1981 and 1984, increasing 25.8% to 2.011 million b/d. Product imports fell to 1.866 in 1985, primarily due to a reduction in product stocks that added 153,000 b/d to the supply in 1985. Product imports jumped back up again in 1986, increasing to 2.045 million b/d, an increase of 179,000 b/d. A substantial portion of this increase was accounted for by an increase in resid imports, which moved up 159,000 b/d in 1986, in response to the jump in resid demand. U.S. refiners are not set up to optimize resid production, so this sudden surge in demand was met by imports.

Even though resid imports fell off a bit in 1987, product imports remained relatively high at 2.004 million b/d. Resid imports fell 104,000 b/d in 1987. But part of this decision was made up for by increased motor gasoline imports, up 58,000 b/d.

Product imports in 1988 jumped up 14.5%, an increase of 291,000 b/d, to 2.295 million b/d. The increase was in all major product groups. Motor gasoline imports were up 21,000 b/d, distillate imports were up 47,000 b/d, resid imports were up 79,000 b/d and imports of all other various petroleum products were up 144,000 b/d.

Product imports in 1989 slipped a bit, to 2.217 million b/d. Motor gasoline imports fell 36,000 b/d and resid imports were down 15,000 b/d.

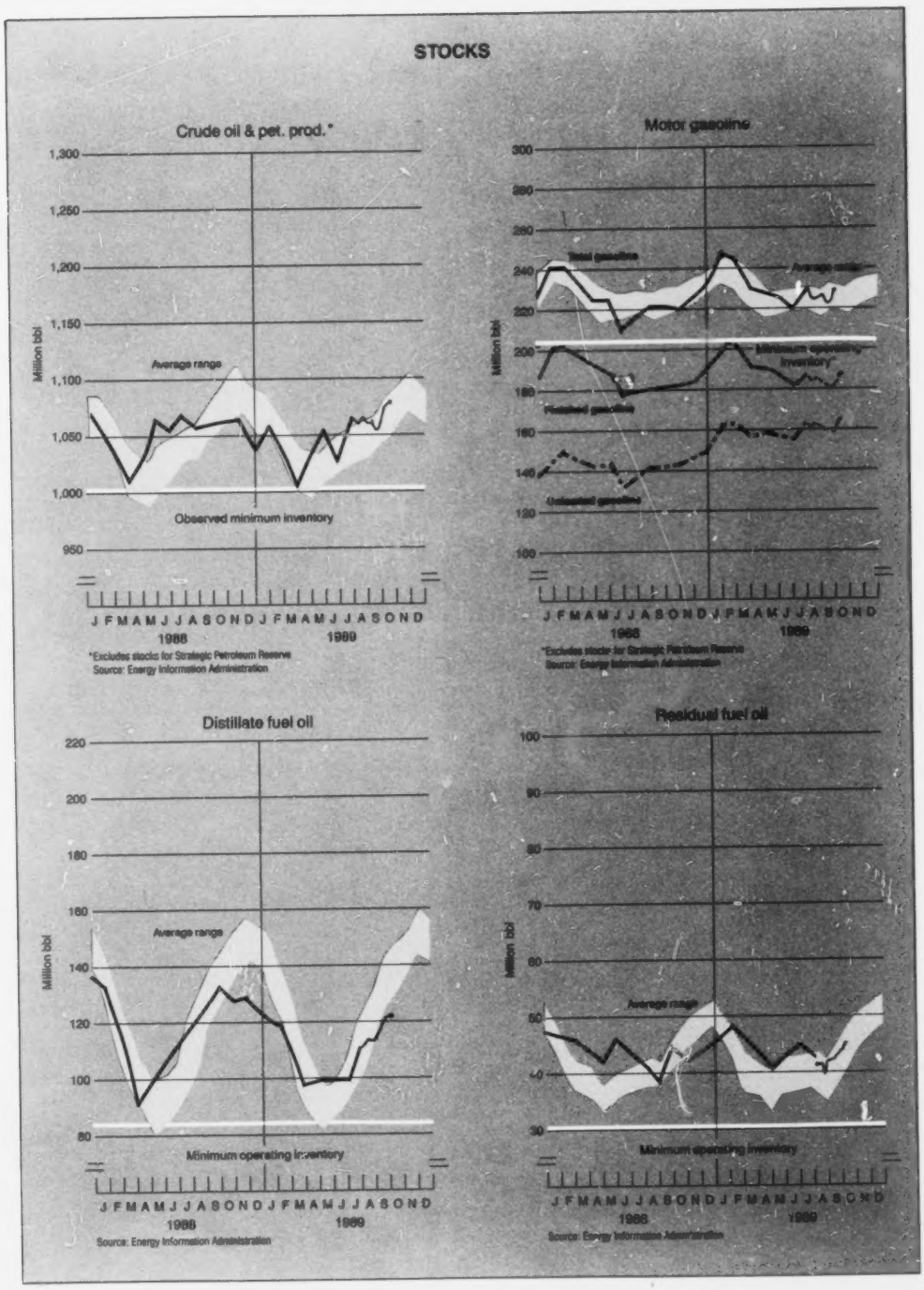
With excess domestic refining capacity, domestic refiners have more incentive to import crude, rather than products. This enables refiners to increase crude runs and lower unit refining costs. In addition, with the pattern of demand relatively uncertain, crude imports offer refiners additional flexibility. They can change yield patterns as required by demand.

But on the other hand, with worldwide excess refining capacity, imported products are often available at low prices, making product imports economically attractive. Flexibility can be retained by simply importing the product required. As additional export refineries come on stream in the Middle East, and U.S. import requirements rise, product imports may move up in the future. The determining factor will obviously be the cost of crude and processing, relative to the cost of imported products.

U.S. import dependency dropped sharply from 1977 to 1983. Prior to that period, total imports as a percentage of domestic demand had risen from 29.1% in 1972 to a peak of 47.7% in 1977. With a drop in demand and declining imports, this ratio fell to 31.6% in 1983. The rebound in imports in 1984 pushed it back up to 33.3%. With the drop in imports in 1985, the dependency ratio fell to 31.5%. But then with the surge in imports in 1986, the dependency ratio shot up to 37.9%. This moved up to 39.6% in 1987, to 42.5% in 1988, and to 46.2% in 1989. The dependency ratio is estimated at 46.2% in 1989. This ratio is expected to climb over the forecast period and soon be over 50%. The import dependency ratio is a key indicator of U.S. vulnerability to some form of oil supply disruption. Another indicator is the source of oil imports.

As imports declined between 1977 and 1985, and the dependency ratio fell, the source of imports shifted away from some of the more volatile areas. Imports from OPEC countries and the Persian Gulf were reduced, thus reducing the U.S. vulnerability to an oil supply disruption.

Crude imports from the Persian Gulf countries were reduced substantially, falling from 2.495 million b/d in 1977 to 245,000 b/d in 1985. Imports from OPEC countries fell 4.331 million b/d, from 5.643 million b/d in 1977 to only 1.312 million b/d in 1985. The share of U.S. crude


STOCKS
Crude oil & pet. prod.*
Million bbl
1,300
1,250
1,200
1,150
1,100
1,050
1,000
950
Average range
Observed minimum inventory
J F M A M J J A S O N D J F M A M J J A S O N D
1988
1989
*Excludes stocks for Strategic Petroleum Reserve
Source: Energy Information Administration
Motor gasoline
Million bbl
300
280
260
240
220
200
180
160
140
120
100
Total gasoline
Average range
Minimum operating inventory
Finished gasoline
(Oxygenated gasoline)
J F M A M J J A S O N D J F M A M J J A S O N D
1988
1989
*Excludes stocks for Strategic Petroleum Reserve
Source: Energy Information Administration
Distillate fuel oil
Million bbl
220
200
180
160
140
120
100
80
Average range
Minimum operating inventory
J F M A M J J A S O N D J F M A M J J A S O N D
1988
1989
Source: Energy Information Administration
Residual fuel oil
Million bbl
100
90
80
70
60
50
40
30
Average range
Minimum operating inventory
J F M A M J J A S O N D J F M A M J J A S O N D
1988
1989
Source: Energy Information Administration

imports from OPEC countries fell from 85.7% in 1976 to 41% in 1985. This favorable trend away from vulnerability was abruptly reversed in 1986. That year crude imports from the OPEC countries jumped up to 2.113 million b/d, an increase of 61.1%. The OPEC share of U.S. crude imports increased to 50.6%. Imports from the Middle East also increased, moving up to 804,000 b/d in 1986 from only 245,000 b/d in 1985. Saudi Arabia became the second leading source of imported crude, providing 618,000 b/d. Mexico was the leading source at 621,000 b/d.

Crude imports from OPEC moved up to 2.4 million b/d in 1987, 51.3% of total crude imports. Saudi Arabia led the way, supplying 642,000 b/d, followed by Nigeria at 529,000 b/d and Venezuela at 488,000 b/d.

Crude imports from OPEC jumped up again in 1988. In that year OPEC imports accounted for 47.6% of total U.S. imports (including the SPR imports). Saudi Arabia was the leading source in 1988, with 1.064 million b/d coming from that country. This is up from only 168,000 b/d in 1985.

In 1989, total imports from OPEC moved up to 4.14 million b/d, 51.4% of the total. Saudi Arabia led the way again at 1.224 million b/d. Total crude and product imports from the OPEC countries moved up from 1.83 million b/d in 1985 to 4.14 million b/d in 1989. This has been an increase of 2.278 million b/d, 126% in four years.

Non-OPEC country imports to the United States also increased over this period. Total imports from the non-OPEC countries was 3.921 million b/d in 1989. This is up 21.1% since 1985, an increase of 684,000 b/d. In 1985, non-OPEC imports accounted for 63.9% of total U.S. imports. This was down to 48.6% in 1989.

Not only is the United States becoming more dependent on imported oil, but it is also becoming more dependent on OPEC oil.

STOCKS. Crude and product stocks do not have a major impact on the long-run demand and supply situation. However, in the short run, stock swings can play a major role in determining the level of supply, the level of imports, and most significantly the short-run price of crude and products. Stocks can be another source of crude oil and petroleum products. And when on the rise, they can also be an element of demand as refiners build supplies for the future.

Total crude and product stocks, excluding stocks for the Strategic Petroleum Reserve, fell 210 million bbl from year end 1980 to year end 1983. This added an average 192,000 b/d to available supply over that three-year period. Stocks went up marginally, 30 million bbl, in 1984 as demand increased, but were reduced again in 1985 as refiners cut costs. Stocks fell an additional 80 million bbl, and at year end 1985 were down 259

NEW YORK MERCANTILE EXCHANGE

Total annual contract volumes
Thousand contracts
(Million barrels)

Year	Total oils	Crude oil	Heating oil	Leaded Gasoline*	Unleaded gasoline
1978	50	—	50	—	—
1979	100	—	100	—	—
1980	240	—	240	—	—
1981	1,010	—	950	60	—
1982	1,850	—	1,725	125	—
1983	2,625	350	1,850	425	—
1984	4,589	1,840	2,092	654	3
1985	6,989	3,981	2,208	667	133
1986	12,858	8,314	3,275	830	439
1987	20,931	14,582	4,293	—	2,056
1988	26,495	18,518	4,923	—	3,054
1989	30,263	20,665	5,243	—	4,355

Trading vs. Deliveries
(Thousand barrels)

	Total deliveries	Trading volume	Deliveries as % of trading volume
Crude oil			
1984	66,780	1,494,976	4.5
1985	157,991	3,581,102	4.4
1986	276,127	7,312,164	3.8
1987	434,032	12,986,458	3.3
1988	612,282	18,518,125	3.3
1989	678,942	20,664,640	3.3
Heating oil			
1984	28,772	2,117,019	1.4
1985	29,861	2,069,901	1.4
1986	48,216	3,034,981	1.6
1987	79,810	4,021,241	2.0
1988	157,554	4,923,343	3.2
1989	188,123	5,243,235	3.6
Unleaded gasoline			
1985	6,684	116,252	5.7
1986	14,068	276,619	5.1
1987	52,645	1,891,088	2.8
1988	127,558	3,053,868	4.2
1989	209,812	4,354,753	4.8

* Leaded gasoline trading ended Oct. 1986.
Source: NYMEX (New York Mercantile Exchange)

STOCK LEVELS AND DAYS' SUPPLY

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Stocks: (1,000 bbl)												
Crude oil*	3309,421	339,080	358,166	363,464	349,730	343,850	345,376	320,892	331,224	348,995	330,359	341,291
Products	896,003	911,784	926,262	889,843	786,367	730,698	760,346	704,561	749,723	717,808	707,358	660,271
Total	**1,205,424**	**1,250,864**	**1,284,482**	**1,253,307**	**1,136,097**	**1,074,548**	**1,105,722**	**1,025,453**	**1,080,947**	**1,066,803**	**1,037,717**	**1,001,562**
SPR†	58,798	117,687	123,938	230,341	293,827	379,089	450,505	493,316	511,565	540,648	559,515	579,857
Demand: (1,000 b/d)												
Products supplied	18,847	18,513	17,056	16,058	15,296	15,231	15,726	15,726	16,281	16,665	17,283	17,325
Days supply:												
Product stocks	47.54	49.25	54.31	55.41	51.41	47.97	48.35	44.80	46.05	43.07	40.93	38.11
Total stocks	**63.96**	**67.57**	**75.31**	**78.04**	**74.27**	**70.55**	**70.31**	**65.21**	**66.39**	**64.02**	**60.04**	**57.81**

*Excluding SPR. †Strategic Petroleum Reserve.

Source: Energy Information Administration

million barrels from year end 1980. This had added 142,000 b/d to supply over these five years.

Stocks moved up again in 1986, increasing 55 million barrels. This actually added approximately 150,000 b/d to demand in 1986. But then stocks were drawn down again in 1987 falling 15 million barrels. This added about 41,000 b/d to supply in 1987. In 1988, companies reduced total stocks 29 million b/d, adding 79,000 b/d to supply.

In the past, stocks were built up substantially at certain times of the year to meet seasonal swings in demand. In addition, the industry was willing to hold stocks as a buffer against an unexpected surge in demand or a potential supply disruption. When demand started falling in 1979, stocks were retained at a relatively high level, because the duration and extent of the decline were unknown.

The operating philosophy changed as stocks piled up and carrying costs soared. The high inflation rates of the early 1980s made it quite expensive to maintain excess unneeded stocks. To cut costs, a concentrated effort was made to reduce stocks to the minimum level that was operationally feasible. Stocks were slashed and the general operating philosophy of refiners appears to be permanently changed to one of maintaining stock levels close to the minimum operating level.

The buildup in stocks in 1986 was mainly a result of the extremely low prices and the net-back pricing schemes that surfaced at that time. Refiners built up stocks to take advantage of the low crude costs. And many of the net-back pricing arrangements made it highly profitable for refiners to purchase and store large quantities of crude. They were virtually assured of a profit on all product transactions connected to the crude purchased.

But that stock buildup was only temporary. Net back pricing schemes were abandoned by the producing countries, since they appeared to be driving down the price of crude oil at the wellhead. A substantial portion of the stock buildup in 1986 was worked off by mid-1987 and refiners were back to operating at minimum stock levels, in order to reduce costs.

A good measure of the adequacy of stocks to meet demand is the number of days of supply they represent. Total industry stocks represented 58 days supply in 1973. This increased to 78 days at year end 1981. After the sharp reduction in stocks, there was some concern about the adequacy of stock levels, but stocks at year end 1984 still represented over 70 days supply at the reduced demand level of 1984. The additional sharp cut in stocks in 1985 dropped the days sup-

U.S. REFINED PRODUCTS, NATURAL GAS LIQUIDS, AND CRUDE STOCKS

Refined product stocks	1980	1981	1982*	1983	1984	1985	1986	1987	1988	1989
					1,000 bbl					
Gasoline	264,011	256,425	247,085	225,042	246,307	225,148	235,490	228,514	230,771	215,670
Motor†	261,327	253,001	244,279	222,434	243,296	222,839	233,057	226,183	228,403	213,441
Aviation†	2,684	3,424	2,806	2,608	3,011	2,309	2,433	2,331	2,368	2,229
Special naphthas	4,929	3,965	3,474	3,153	2,951	3,909	3,759	3,654	3,487	3,005
Kerosine	11,568	11,042	10,792	7,861	11,893	7,502	8,379	8,447	7,284	5,139
Distillate	205,113	191,541	185,579	140,263	161,072	143,673	155,097	134,485	123,517	105,700
Residual	91,786	77,992	68,229	48,504	53,000	50,381	47,437	47,410	44,621	43,838
Kerosine jet fuel	35,723	34,011	32,001	32,346	35,118	33,825	42,677	41,973	37,723	34,471
Naphtha jet fuel	6,308	7,054	7,189	6,265	6,861	6,654	7,072	7,956	6,051	6,380
Natural gas liquids & LRG	137,460	150,170	114,497	116,817	108,446	81,707	109,532	104,119	103,988	88,806
Unfinished oils	123,900	111,348	105,277	108,018	93,506	106,656	94,022	93,185	99,858	106,191
Other refined products	45,426	46,295	44,023	42,429	41,192	45,106	46,258	48,065	50,058	51,071
Total product stocks	**926,262**	**889,843**	**818,146**	**730,698**	**760,346**	**704,561**	**749,723**	**717,808**	**707,358**	**660,271**
Crude stocks§	358,166	363,464	350,044	343,850	345,376	320,892	331,224	348,995	330,359	341,291
Total stocks	**1,284,482**	**1,253,307**	**1,168,190**	**1,074,548**	**1,105,722**	**1,025,453**	**1,080,947**	**1,066,803**	**1,037,717**	**1,001,562**

*Change in Energy Information Administration reporting basis. †Includes blending components. §Excludes stocks for Strategic Petroleum Reserve.

Source: Energy Information Administration

ply to 65.2 days at year end 1985. This was the lowest level since 1974. This moved up to 64 days in 1987, but then dipped to 60.2 days supply in 1988. It fell sharply to 57.8 days at year end 1989. This placed stocks at close to minimum levels and refiners are now trying to maintain a balance between rising demand and stocks, and avoid any potential supply disruptions.

Most of the reduction in stocks has been in product stocks. From year end 1981 to year end 1989, total industry stocks have been reduced 253 million barrels. Crude stocks have been reduced only 22 million barrels, while product stocks have fallen 231 million barrels. Refiners find it advantageous to maintain higher crude stocks. With excess refining capacity available, refiners can run crude to meet unexpected swings in product demand.

But stocks now appear to be at a minimum level if supply disruptions are to be avoided. With demand expected to rise in the future, it does not appear that stocks will be reduced substantially.

Crude oil stocks in the Strategic Petroleum Reserve surpassed industry crude oil stocks in July 1983. At year end 1989, SPR stocks were 580 million barrels while industry crude stocks were only 341 million barrels.

The fill rate for the SPR has become sort of a political football. Those placing emphasis on energy security push for a higher fill rate. While those concerned more with government expenditures and budget deficits call for a lower fill rate or total suspension of SPR crude purchases. The domestic independent producers have asked that it be filled partially with crude from domestic stripper wells so that these wells are not shut in.

The SPR does potentially provide a backup in case of an emergency. However, at year end 1989, it represented only about 33.5 days of supply at the 1989 rate of demand. But the biggest problem with the SPR program is that there is no clear-cut procedure for its use in case of an emergency. Without some program for implementation, the SPR is of little use in preventing a surge in prices if there is a supply disruption and the market gets out of balance.

There is an additional element of supply, primarily processing gain from refining operations. This expansion during crude processing added about 860,000 b/d to supply in 1989. It is anticipated that with demand in general going up, and demand for light products growing, processing gain will move up.

Another element of risk has been added

AVERAGE ANNUAL PRICE OF CRUDE OIL

Year	U.S. average wellhead price		Saudi Arabian light crude	
	Current dollars	Constant 1982 dollars	Current dollars	Constant 1982 dollars
1950	2.51	9.19	—	—
1951	2.53	8.32	1.75	5.76
1952	2.53	8.55	1.75	5.91
1953	2.68	9.18	1.97	6.75
1954	2.78	9.49	1.97	6.72
1955	2.77	9.45	1.97	6.72
1956	2.79	9.21	1.97	6.50
1957	3.09	9.90	2.08	6.67
1958	3.01	9.53	2.08	6.58
1959	2.90	9.15	1.90	5.99
1960	2.88	9.09	1.80	5.68
1961	2.89	9.15	1.80	5.70
1962	2.90	9.15	1.80	5.68
1963	2.89	9.15	1.80	5.70
1964	2.88	9.11	1.80	5.70
1965	2.86	8.85	1.80	5.57
1966	2.88	8.65	1.80	5.41
1967	2.92	8.74	1.80	5.39
1968	2.94	8.60	1.80	5.26
1969	3.09	8.68	1.80	5.06
1970	3.18	8.62	1.80	4.88
1971	3.39	8.90	2.29	6.01
1972	3.39	8.52	2.48	6.23
1973	3.89	8.64	5.04	11.20
1974	6.87	12.84	11.25	21.03
1975	7.67	13.13	12.38	21.20
1976	8.19	13.40	11.51	18.84
1977	8.57	13.20	12.70	19.57
1978	9.00	12.88	12.70	18.17
1979	12.64	16.06	24.00	30.50
1980	21.59	24.04	32.00	35.63
1981	31.77	32.42	34.00	34.69
1982	28.52	28.52	34.00	34.00
1983	26.19	25.85	29.00	28.63
1984	25.88	24.96	29.00	27.97
1985	24.09	23.34	28.00	27.13
1986	12.51	12.49	15.05	15.02
1987	15.40	14.98	17.53	17.05
1988	12.58	11.77	13.71	12.83
1989	15.85	14.13	16.18	14.42
1990E	19.00	16.55	19.40	16.90

Note: Prices for Saudi Arabian light crude are official government posted prices 1950–1985; average selling price 1986–1989.

to the crude supply market and refinery crude trading operations over the past several years. The excess capacity situation in the world crude market has led to a very competitive trading atmosphere in crude oil and petroleum products. This has resulted in the rapid expansion of spot market transactions and the development of a futures market for major products and crude oil. Transactions have become dominated by spot market trading and/or supply contracts with the price connected to the spot market. The net-back pricing arrangements eliminated some of the risk for refiners during 1986. But those arrangements were short-lived since they tended to exert additional downward pressure on prices by encouraging product price competition.

Although OPEC is trying to reestablish posted contract prices, the vast majority of the trading is still a form of spot market trading with its inherent risks. More and more refiners and others involved in trading products or crude are turning to the futures market to reduce the risk.

The futures market is not a source of supply, but it does influence prices and therefore supply decisions. Total annual contract volumes for crude and products traded on the New York Mercantile Exchange have moved up rapidly. They went from 50,000 contracts in 1978 (50 million barrels) to 6,989,000 contracts in 1985, 12,858,000 in 1986, 20,931,000 in 1987, 26,945,000 in 1988 and 30,263,000 contacts in 1989. The futures market has become an important barometer of the volatile movement in prices in today's market.

OUTLOOK

It is obvious that U.S. supply could be affected by any upheaval that has an impact on worldwide oil supplies. The U.S. imports almost half of the oil it consumes, and these imports could become scarce or costly. However, initially it did not appear that the conflict in the Middle East would have an impact on domestic production. But this too will be affected. All aspects of the supply side of the U.S. petroleum balance will be affected by the recent changes in the world oil markets.

The invasion of Kuwait by neighboring Iraq in early August 1990 has had a substantial impact on the demand supply relationship in the worldwide petroleum industry. These two countries together were producing around 4.7 million b/d at the time of the invasion. The subsequent embargo of crude oil from Iraq and Kuwait removed close to 4.2 million b/d in exports from these two nations. In addition, 300,000 b/d of pro-

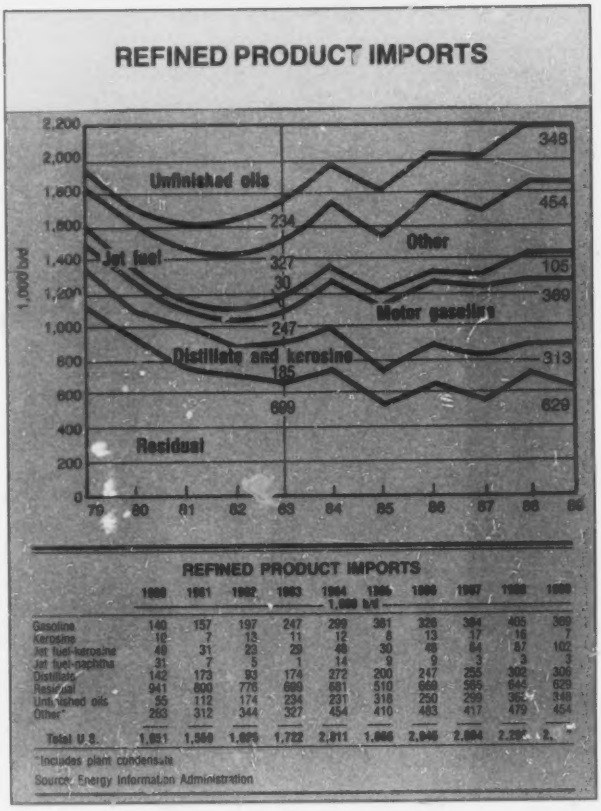
duction from the Kuwaiti share of the Neutral Zone was also affected by these events.

The sharp reduction in worldwide crude oil supply had an almost immediate impact on crude oil prices. Prices were on the rise before the invasion and moved up sharply after. The average price of world export crude oils increased 50% in the three weeks following the invasion. Prices on the futures market moved up over $30/bbl and hit the highest level since 1985.

There is no way to determine if the sharp rise in prices has had an impact on demand for petroleum products. However, it is fairly safe to assume that an increase in oil prices of that magnitude will have a substantial impact on demand. The impact will go beyond the demand for petroleum products. If oil prices remain higher for an extended period, other energy costs will begin to move up as fuel substitution increases the demand for other fuels. The resulting increase in energy costs will have an impact on economic growth.

At this time it is uncertain how long the crisis involving Iraq and Kuwait will last. It is quite probable that the loss of this volume of crude oil will exert upward pressure on crude oil prices as long as the crisis continues. This makes it almost impossible to project with any certainty the most likely trend in economic growth, energy demand, demand for petroleum products and petroleum production.

Therefore, for the first time in this edition of the Oil Industry Outlook, three scenarios are being presented. The three scenarios vary in expectations of the length of time the crisis in the Persian Gulf will last. The length of time the oil crisis continues will have an impact on the price of crude oil, the cost of energy, the rate of economic growth, the level of energy consumption, the level of petroleum product demand, the level of imports and the level of domestic production. To cover these variations three separate forecasts are presented. The forecast with the highest degree of probability is the one that comes closest to the length of time it takes to finally resolve this issue in the Middle East, and for Iraqi and Kuwaiti oil to return to the market.



REFINED PRODUCT IMPORTS

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
					1,000 b/d					
Gasoline	140	157	197	247	299	381	328	384	405	369
Kerosine	12	7	13	11	12	8	13	17	16	7
Jet fuel-kerosine	48	31	23	29	48	30	48	84	87	102
Jet fuel-naphtha	31	7	5	1	14	9	2	3	3	3
Distillate	142	173	93	174	272	200	247	255	302	308
Residual	941	800	776	699	681	510	668	595	645	629
Unfinished oils	55	112	174	234	231	318	250	299	354	348
Other*	263	312	344	327	454	410	483	417	479	454
Total U.S.	1,631	1,599	1,625	1,722	2,811	1,866	2,945	2,894	2,292	2,...

*Includes plant condensate
Source: Energy Information Administration

Scenario I—The situation in the Middle East lasts for an extended period. The embargo of oil exported from Iraq and Kuwait continues for a period of 6–18 months. The vast majority of oil production in Iraq and Kuwait is shut in for the duration of the dispute. Production and exports from the Kuwaiti half of the Neutral Zone are also curtailed during this period. Oil production capacity in other OPEC areas is not affected by the dispute. Following the settlement of the dispute, production in Iraq and Kuwait is resumed at levels close to the production levels prior to the invasion.

Scenario II—The situation in the Middle East lasts for an even longer time period than in

Scenario I. —The embargo of oil exported from Iraq and Kuwait continues for a period of 18–30 months. The vast majority of oil production in Iraq and Kuwait is shut in for the extended duration of the dispute. Production and exports from the Kuwaiti half of the Neutral Zone are also curtailed during this period. Oil production capacity in other OPEC areas is not affected by the dispute. Following the settlement of the dispute, production in Iraq and Kuwait is resumed at levels close to the production levels prior to the invasion.

Scenario III—The situation in the Middle East lasts for a relatively short period of time. The embargo of oil exported from Iraq and Kuwait continues for less than six months. The vast majority of oil production in Iraq and Kuwait is shut in during this period. Production and exports from the Kuwaiti half of the Neutral Zone are also curtailed during this short period. Production capacity in other OPEC countries is not affected by this dispute. Following settlement of the dispute, production in Iraq and Kuwait is resumed at production levels close to those prior to the invasion.

The major differences between the three scenarios is the length of time that the crisis continues and Iraqi and Kuwaiti oil is off the market. But even though the length of time until settlement of the dispute is the only apparent difference, these three scenarios will cause three distinct sets of conditions in the oil market. And the different market conditions will create differing projections of demand for energy and petroleum products over the forecast period, 1991–95.

The disruption of oil production and oil exports from Iraq and Kuwait will have an immediate impact on crude oil and petroleum product prices. And it is expected that the loss of this oil will tighten the market and place upward pressure on prices while the crisis lasts. Prices will fluctuate with seasonal demand because requirements for OPEC oil will come close to capacity during the periods of peak demand. As demand approaches capacity, prices will be bid up by refiners and traders looking for supplies to meet winter demand.

With the elimination of supplies from Iraq and Kuwait, a substantial portion of the OPEC excess capacity has been eliminated. Therefore as long as that production remains shut in, the crude oil market will be tight, with little contingency production capacity available. Prices will remain much higher than they would be if this capacity was available to the market.

The impact of the reduction of worldwide crude supplies is transferred to the U.S. domestic market almost instantaneously by the price mechanism and the futures market. The loss of the export crude from Iraq and Kuwait tightened the world market and boosted oil prices. Domestic crude oil prices moved up along with the increase in world export prices. U.S. domestic wellhead prices will continue to be influenced and will follow world prices throughout the forecast period.

SCENARIO I—The loss of the export crude oil and production capacity of Iraq and Kuwait will result in higher crude oil prices throughout 1991. The U.S. average wellhead price for domestic crude oil will be 25% higher in 1991 than in 1990. The average price of West Texas Intermediate crude oil (the marker crude for the futures exchange) will also be up 25%. After the Middle East dispute is resolved, oil prices will fall in 1992. The average prices will be down 22% in 1992, falling to a level lower than 1990. Prices will move up gradually throughout the remainder of the forecast period due to increased U.S. and worldwide demand for crude oil. However, average prices in 1995 will only be up 12.9% from the average price in 1990.

SCENARIO II—The loss of the export crude oil and production capacity of Iraq and Kuwait will result in higher crude oil prices throughout 1991 and 1992. The U.S. average wellhead price for domestic crude oil will be 25% higher in 1991 than in 1990. The average price of West Texas Intermediate crude oil (the marker crude for the futures exchange) will also be up 25%. Crude prices will move up an additional 10% in 1992 due to a modest increase in demand

worldwide and a tight worldwide crude supply. After the Middle East dispute is resolved, oil prices will fall in 1993. The average prices will fall 30% in 1993, falling to a level lower than 1990. Prices will move up gradually throughout the remainder of the forecast period due to increased U.S. and worldwide demand for crude oil. However, average prices in 1995 will only be up 9.7% from the average price in 1990.

SCENARIO III—The loss of the export crude oil and production capacity of Iraq and Kuwait will result in higher crude oil prices only for a short period of time, through late 1990 and possibly into early 1991. Prices will fall in 1991, following the settlement of the Middle East dispute. The U.S. average wellhead price for domestic crude oil will be 7.5% lower in 1991 than in 1990. The average price of West Texas Intermediate crude oil (the marker crude for the futures exchange) will also be down about 7.5%. Prices will move up gradually throughout the forecast period due to increased U.S. and worldwide demand for crude oil. Average prices in 1995 will be up 18.6% from the average price in 1990.

Over the forecast period the increased demand for petroleum products is expected to help reduce the worldwide excess crude capacity that is exerting the downward pressure on prices. Therefore crude oil prices are projected to move up over the forecast period even after the crude oil from Iraq and Kuwait returns to the market. But prices are going to move up slowly, along with increased demand, and will probably remain below the high price levels that prevailed during the 1981–85 period. Prices jumped up to $21.59/bbl in 1980 and then to an average $31.77/bbl in 1981. Prices started to move down over the next four years but still averaged $24.09/bbl in 1985.

Incentives for exploration, drilling and production in the United States were a lot greater during those years than they were during the period following the price break in 1986. The price increase projected will restore only a portion of the financial incentive that existed from 1981 to 1985.

The impact on domestic supply will vary with each of the scenarios. But in all three cases the expected longer-term price level will stimulate demand but it is not expected to be a major stimulus for domestic supply. That sharp drop in crude oil prices in 1986 brought the decline curve back into projections of U.S. domestic crude oil production. The lower price level stopped a great deal of exploration and drilling activity. It also slowed enhanced recovery projects and a lot of remedial work on older wells. A vast number of small stripper wells were abandoned.

The decline in U.S. production is expected to continue at varying rates throughout the forecast period and beyond. The projected increase in crude oil prices is expected to result in additional exploration and production activity. However, the increase will not be sufficient to prevent the decline in U.S. output. Lower-48 output will continue the slide that was restarted in 1986. And adding to the problem is the probable peaking and decline of Alaskan output. Prudhoe Bay production has already peaked. Without additional exploration activity, total Alaskan production has hit its peak in 1988 and has already begun to decline.

The decline rate may be slowed somewhat due to the slightly higher price level. Additional drilling, increased secondary recovery activity and a longer life for stripper wells will result in more production than under a lower-price scenario. But it will be impossible to stop the slide under these economic conditions. A massive exploration and drilling effort would have to be launched in order to eliminate the decline. Replacing reserves is essential to the long-term viability of the domestic industry and to U.S. energy security. But worldwide economic forces do not currently support exploitation of these higher-cost domestic resources. If the energy security issue is of concern, then the government will have to take action to assist the industry by reducing the tax burden and in some cases eliminating other restrictions such as excessive environmental impediments.

Something will to have to be done about the developing obstruction to exploration activity because of environmental concerns. Some serious economic analysis will be required to balance the twin goals of assuring economic growth and protecting the environment in a totally pristine state.

SCENARIO I—U.S. crude production will not be greatly affected by the increase in crude prices through 1991. There will be an increase in exploration and drilling activity but it will not be sufficient to do anything but slightly slow the decline in U.S. output. U.S. domestic crude oil production will fall throughout the forecast period. Domestic output at the end of the forecast period, 1995, will be down 8.8%, at 6.59 million b/d. This is a drop of 635,000 b/d. Total liquids production, crude oil plus natural gas liquids, will fall 490,000 b/d, 5.5%, to 8.34 million b/d.

SCENARIO II—U.S. crude production will be affected somewhat more by the increase in crude prices for a longer period through 1991 and 1992. There will be an increase in exploration and drilling activity. Again it will not be sufficient to do much about the decline in U.S. output, but it will slow the decline more than under Scenario I. U.S. domestic crude oil production will fall throughout the forecast period. Domestic output at the end of the forecast period, 1995, will be down 7.8%, at 6.66 million b/d. This is a drop of 565,000 b/d. Total liquids production, crude oil plus natural gas liquids, will fall 425,000 b/d, 4.8%, to 8.405 million b/d.

SCENARIO III—U.S. crude production will not be affected by the increase in crude prices at the end of 1990. There will be a very slight price-induced increase in exploration and drilling activity but it will not slow the decline in U.S. domestic output. U.S. domestic crude oil production will fall throughout the forecast period. Domestic output at the end of the forecast period, 1995, will be down 9.8%, at 6.51 million b/d. This is a drop of 710,000 b/d. Total liquids production, crude oil plus natural gas liquids, will fall 560,000 b/d, 6.3%, to 8.26 million b/d.

Lower domestic production and increasing domestic demand will result in an ever-widening gap between domestic supply and demand. And this gap will have to be filled by imports. This will be true under any of the three scenarios. U.S. dependency on imported oil will move up over the forecast period for the same reasons, increasing U.S. demand for petroleum products and declining domestic liquids production.

SCENARIO I—Total industry imports, excluding crude imports for the Strategic Petroleum Reserve, are projected to increase 20.7% over the forecast period 1991–95. Total industry imports will be up to 10.02 million b/d, an increase of 1.715 million b/d. With higher product and crude oil prices in 1991, the growth in imports will be slowed a bit due to smaller growth in demand and a slowing in the decline rate in domestic production. But after prices fall in 1992, and demand is stimulated, the import growth will also pick up. By 1992, imports will be at a record high when they reach 9.04 million b/d. The previous annual record was 8.786 million b/d in 1977. Crude oil imports will be up 27.3%, increasing to 7.655 million b/d in 1995. This will also be a record high for crude oil imports. The previous high was 6.594 million b/d, also in 1977. A new record high will be reached by 1992. With substantial refining capacity available in the U.S., refiners prefer to import crude rather than products. Therefore, product imports are not expected to move up as rapidly. Product imports are forecast to move up 3.3%, to 2.365 million b/d in 1995. This situation could change if foreign products become available at prices lower than domestic products. In that case, product imports could increase substantially. With declining U.S. production and increasing imports, dependency on imported oil will increase markedly over the forecast period. Total imports as a percentage of domestic demand will move up from 48.3% in 1990 to 54.5% in 1995. This will be an all-time high. Net imports (total imports less exports), as a percentage of domestic demand, will increase from 43.5% in 1990 to 49.9% in 1995. This will also be a record high.

SCENARIO II—Total industry imports, excluding

crude imports for the Strategic Petroleum Reserve, are projected to increase 18.1% over the forecast period 1991–95. Total industry imports will be up to 9.805 million b/d, an increase of 1.5 million b/d. With higher product and crude oil prices in 1991 and 1992, the growth in imports will be slowed a bit due to a smaller growth in demand and a slowing in the decline rate in domestic production. But after prices fall in 1993, and demand is stimulated, the import growth will also pick up. By 1993, imports will be at a record high when they reach 9.19 million b/d. The previous annual record was 8.786 million b/d in 1977. Under this scenario, crude oil imports will be up 24%, increasing to 7.46 million b/d in 1995. This will also be a record high for crude oil imports. The previous high was 6.594 million b/d, also in 1977. A new record high will be reached by 1993. With substantial refining capacity available in the U.S., refiners prefer to import crude rather than products. Therefore, product imports are not expected to move up as rapidly. Product imports are forecast to move up 2.4%, to 2.345 million b/d in 1995. This situation could change if foreign products become available at prices lower than domestic products. In that case, product imports could increase substantially. With declining U.S. production and increasing imports, dependency on imported oil will increase markedly over the forecast period. Total imports as a percentage of domestic demand will move up from 48.3% in 1990 to 53.8% in 1995. This will be an all-time high. Net imports (total imports less exports), as a percentage of domestic demand, will increase from 43.5% in 1990 to 49.2% in 1995. This will also be a record high.

SCENARIO III—Total industry imports, excluding crude imports for the Strategic Petroleum Reserve, are projected to increase 21.5% over the forecast period 1991–95. Total industry imports will be up to 10.385 million b/d, an increase of 1.835 million b/d. The rise in prices at the end of 1990 will have little impact on the growth of imports. For the first year of the forecast period, 1991, imports will be at a record high when they reach 8.88 million b/d. The previous annual record was 8.786 million b/d in 1977. Crude oil imports will be up 27.8%, increasing to 7.985 million b/d in 1995. This will also be a record high for crude oil imports. The previous high was 6.594 million b/d, also in 1977. A new record high will be reached by 1992. With substantial refining capacity available in the U.S., refiners prefer to import crude rather than products. Therefore, product imports are not expected to move up as rapidly. Product imports are forecast to move up 4.3% to 2.4 million b/d in 1995. This situation could change if foreign products become available at prices lower than domestic products. In that case, product imports could increase substantially. With declining U.S. production and increasing imports, dependency on imported oil will increase markedly over the forecast period. Total imports as a percentage of domestic demand will move up from 49.5% in 1990 to 55.7% in 1995. This will be an all-time high. Net imports (total imports less exports), as a percentage of domestic demand, will increase from 44.7% in 1990 to 51% in 1995. This will also be a record high.

By the end of the forecast period, the United States will be more dependent on foreign oil than it was in the late 1970s. And the dependency will be on the rise with no end in sight.

The dependency will be on OPEC oil and will probably make the imports more vulnerable to supply disruptions and the economy more vulnerable to energy disruptions. Since non-OPEC production is not expected to increase over this period, the additional imports will have to come mainly from OPEC sources. Imports from OPEC countries are expected to increase to close to 60% of total U.S. imports by the end of the forecast period.

Stocks will not play a major role in the supply picture over the forecast period. Stocks are currently at close to a minimum level for operational efficiency. Expectations are that stocks will be increased as demand moves up over the forecast period.

U.S. SUPPLY KEYS TO THE FUTURE SCENARIO I

1. The average price of U.S. crude oil at the wellhead oil will follow the worldwide export prices and will increase 25% in 1991. But the price will then fall sharply in 1992 after the Middle East dispute is settled. Increased U.S. and worldwide demand for crude oil will result in a gradual increase in prices over the remainder of the forecast period. The price will move up faster than the rate of inflation but it will remain below the high prices of the 1981–85 period. The price level will remain dependent upon international market conditions and OPEC actions.

2. The increase in prices in 1991 will give a modest boost to U.S. exploration, drilling and production activities. However, the price rise will not be sufficient to stimulate a level of activity that would have a major impact on domestic production trends.

3. Production in the lower-48 states will continue to decline. The rate of decline will be slowed a bit by increased drilling and other production activities. Alaskan production peaked in 1988 and will also decline during the forecast period. The rate of decline in Alaska will depend upon future exploration activities. And future exploration activity will depend upon how the environmental issues are resolved.

4. Total U.S. crude production will fall to 6.59 million b/d in 1995, down 8.8% over the five years. This will be the lowest output since 1954.

5. Total imports will increase to fill the gap between increasing domestic demand and declining domestic production. Total imports will set record highs by 1992 and will be up 20.7%, at 10.02 million b/d in 1995.

6. Dependency on imports will hit a new high in 1991 and will continue up to 54.5% in 1995. Most of the increase in imports will come from OPEC countries.

7. The domestic refining industry will be able to handle the increase in product demand. Some increase in capacity may be required. The industry will continue to operate as efficiently as possible, minimizing stock levels and carrying costs, and trying to maximize the utilization rate.

THE OUTLOOK — U.S. SUPPLY
SCENARIO — I

	1989	1990	1991	1992	1993	1994	1995	Change 1990 to 1995	% change 1990 to 1995
PETROLEUM BALANCE									
(thousand barrels/day)									
DEMAND:									
Domestic demand	17,325	17,190	17,290	17,620	17,900	18,135	18,370	+1,180	+ 6.9
Exports	859	830	810	830	840	850	860	+30	+ 3.6
Total demand	**18,184**	**18,020**	**18,100**	**18,450**	**18,740**	**18,985**	**19,230**	**+1,210**	**+ 6.7**
SUPPLY:									
Crude production	7,613	7,225	7,080	6,905	6,760	6,660	6,590	−635	− 8.8
NGL & other hydrocarbons	1,606	1,605	1,635	1,655	1,685	1,720	1,750	+145	+ 9.0
Total liquids production	**9,219**	**8,830**	**8,715**	**8,560**	**8,445**	**8,380**	**8,340**	**−490**	**− 5.5**
Crude imports (ex. SPR)	5,788	6,015	6,240	6,725	7,130	7,410	7,655	+1,640	+27.3
Product imports	2,217	2,290	2,300	2,315	2,330	2,350	2,365	+ 75	+ 3.3
Total industry imports	**8,005**	**8,305**	**8,540**	**9,040**	**9,460**	**9,760**	**10,020**	**+1,715**	**+20.7**
Other supply	859	855	860	875	890	900	910	+55	+ 6.4
Total supply	**18,083**	**17,990**	**18,115**	**18,475**	**18,795**	**19,040**	**19,270**	**+1,280**	**+ 7.1**
TOTAL STOCKS:									
(million barrels) (year end)									
Crude stocks	341	330	335	340	350	355	360	+30	+ 9.1
Product stocks	660	660	660	675	685	700	710	+50	+ 7.6
Total industry stocks	**1,007**	**990**	**995**	**1,015**	**1,035**	**1,055**	**1,070**	**+80**	**+ 8.1**
SPR crude stocks	580	600	620	640	660	680	700	+100	+16.7
Total U.S. stocks	**1,581**	**1,590**	**1,615**	**1,655**	**1,695**	**1,735**	**1,770**	**+180**	**+11.3**
Industry stocks — days supply	57.8	57.6	57.5	57.6	57.8	58.2	58.2	+ 0.6	+ 1.0
IMPORT DEPENDENCY									
Net imports — % of domestic demand	41.2	43.5	44.7	46.6	48.2	49.1	49.9	+ 6.4	+14.7
Total imports — % of domestic demand	46.2	48.3	49.4	51.3	52.8	53.8	54.5	+ 6.2	+12.8
Crude imports — % of crude supply	43.2	45.4	46.8	49.3	51.3	52.7	53.7	+ 8.3	+18.3
CRUDE OIL PRICE									
($/barrel)									
U.S. average wellhead	15.85	19.05	23.80	18.60	19.55	20.50	21.50	+2.45	+12.9
West Texas intermediate (posted)	18.25	21.90	27.35	21.40	22.50	23.60	24.60	+2.70	+12.3

U.S. SUPPLY KEYS TO THE FUTURE SCENARIO II

1. The average price of U.S. crude oil at the wellhead oil will follow the worldwide export prices and will increase 25% in 1991. Since the dispute in the Middle East is not settled, the price will move up an additional 10% in 1992. The price will then fall sharply in 1993 after the Middle East dispute is settled. Increased U.S. and worldwide demand for crude oil will result in a gradual increase in prices over the remainder of the forecast period. In the latter years of the forecast period, the price will move up faster than the rate of inflation, but it will remain below the high prices of the 1981–85 period. The price level will remain dependent upon international market conditions and OPEC actions.

2. The increase in prices in 1991 and 1992 will give a modest boost to U.S. exploration, drilling and production activities. However, the price rise will not be sufficient to stimulate a level of activity that would have a major impact on domestic production trends.

3. Production in the lower-48 states will continue to decline. The rate of decline will be slowed a bit by the increased drilling and other production activities. Alaskan production peaked in 1988 and will also decline during the forecast period. The rate of decline in Alaskan production will depend upon future exploration activities. And future exploration activity will depend upon how the environmental issues are resolved.

4. Total U.S. crude production will fall to 6.66 million b/d in 1995, down 7.8% over the five years. This will be the lowest output since 1954.

5. Total imports will increase to fill the gap between increasing domestic demand and declining domestic production. Total imports will set a record high by 1993 and will be up 18.1%, at 9.805 million b/d in 1995.

6. Dependency on imports will hit a new high in 1991 and will continue up to 53.8% in 1995. Most of the increase in imports will come from OPEC countries.

7. The domestic refining industry will be able to handle the increase in product demand. Some increase in capacity may be required. The industry will continue to operate as efficiently as possible, minimizing stock levels and carrying costs, and trying to maximize the utilization rate.

THE OUTLOOK — U.S. SUPPLY
SCENARIO — II

	1989	1990	1991	1992	1993	1994	1995	Change 1990 to 1995	% change 1990 to 1995
PETROLEUM BALANCE									
(thousand barrels/day)									
DEMAND:									
Domestic demand	17,325	17,190	17,290	17,410	17,710	17,960	18,210	+1,020	+ 5.9
Exports	859	830	810	800	820	840	850	+20	+ 2.4
Total demand	**18,184**	**18,020**	**18,100**	**18,210**	**18,530**	**18,800**	**19,060**	**+1,040**	**+ 5.8**
SUPPLY:									
Crude production	7,613	7,225	7,080	6,940	6,835	6,735	6,660	−565	− 7.8
NGL & other hydrocarbons	1,606	1,605	1,635	1,665	1,680	1,710	1,745	+140	+ 8.7
Total liquids production	**9,219**	**8,830**	**8,715**	**8,605**	**8,515**	**8,445**	**8,405**	**−425**	**− 4.8**
Crude imports (ex. SPR)	5,788	6,015	6,240	6,450	6,880	7,195	7,460	+1,445	+24.0
Product imports	2,217	2,290	2,300	2,305	2,310	2,325	2,345	+ 55	+ 2.4
Total industry imports	**8,005**	**8,305**	**8,540**	**8,755**	**9,190**	**9,520**	**9,805**	**+1,500**	**+18.1**
Other supply	859	855	860	865	880	890	905	+50	+ 5.8
Total supply	**18,083**	**17,990**	**18,115**	**18,225**	**18,585**	**18,855**	**19,115**	**+1,125**	**+ 6.3**
TOTAL STOCKS:									
(million barrels) (year end)									
Crude stocks	341	330	335	335	340	350	360	+30	+ 9.1
Product stocks	660	660	660	665	680	690	700	+40	+ 6.1
Total industry stocks	**1,001**	**990**	**995**	**1,000**	**1,020**	**1,040**	**1,060**	**+70**	**+ 7.1**
SPR crude stocks	580	600	620	640	660	680	700	+100	+16.7
Total U.S. stocks	**1,581**	**1,590**	**1,615**	**1,640**	**1,680**	**1,720**	**1,760**	**+170**	**+10.7**
Industry stocks — days supply	57.8	57.6	57.5	57.4	57.6	57.9	58.2	+ 0.6	+ 1.0
IMPORT DEPENDENCY									
Net imports — % of domestic demand	41.2	43.5	44.7	45.7	47.3	48.3	49.2	+ 5.7	+13.1
Total imports — % of domestic demand	46.2	48.3	49.4	50.3	51.9	53.0	53.8	+ 5.5	+11.4
Crude imports — % of crude supply	43.2	45.4	46.8	48.2	50.2	51.7	52.8	+ 7.4	+16.3
CRUDE OIL PRICE									
($/barrel)									
U.S. average wellhead	15.85	19.05	23.80	26.20	18.10	19.50	20.90	+1.85	+ 9.7
West Texas intermediate (posted)	18.25	21.90	27.35	30.10	20.80	22.40	24.00	+2.10	+ 9.6

U.S. SUPPLY
KEYS TO THE FUTURE
SCENARIO III

1. The average price of U.S. crude oil at the wellhead oil will follow the worldwide export prices and will remain high only through 1990. The price will then fall sharply in 1991 after the Middle East dispute is settled. Increased U.S. and worldwide demand for crude oil will result in a gradual increase in prices over the forecast period. The price will move up faster than the rate of inflation but it will remain below the high prices of the 1981–85 period. The price level will remain dependent upon international market conditions and OPEC actions.

2. The temporary increase in prices in 1990 will not give much of a boost to U.S. exploration, drilling and production activities. Prices will move up over the forecast period but the price rise will not be sufficient to stimulate a level of activity that would have a major impact on domestic production trends.

3. Production in the lower-48 states will continue to decline. The rate of decline will be slowed a bit by increased drilling and other production activities. Alaskan production peaked in 1988 and will also decline during the forecast period. The rate of decline in Alaska will depend upon future exploration activities. And future exploration activity will depend upon how the environmental issues are resolved.

4. Total U.S. crude production will fall to 6.51 million b/d in 1995, down 9.8% over the five years. This will be the lowest output since 1954.

5. Total imports will increase to fill the gap between increasing domestic demand and declining domestic production. Total imports will set a record highs by 1991 and will be up 21.5%, at 10.385 million b/d in 1995.

6. Dependency on imports will hit a new high in 1991 and will continue up to 55.7% in 1995. Most of the increase in imports will come from OPEC countries.

7. The domestic refining industry will be able to handle the increase in product demand. Some increase in capacity may be required. The industry will continue to operate as efficiently as possible, minimizing stock levels and carrying costs, and trying to maximize the utilization rate.

THE OUTLOOK — U.S. SUPPLY
SCENARIO — III

	1980	1990	1991	1992	1993	1994	1995	Change 1990 to 1995	% change 1990 to 1995
PETROLEUM BALANCE									
(thousand barrels/day)									
DEMAND:									
Domestic demand	17,325	17,290	17,530	17,855	18,135	18,385	18,645	+1,355	+ 7.8
Exports	859	830	840	850	860	870	880	+50	+ 6.0
Total demand	**18,184**	**18,120**	**18,370**	**18,705**	**18,995**	**19,255**	**19,525**	**+1,405**	**+ 7.8**
SUPPLY:									
Crude production	7,613	7,220	7,030	6,820	6,680	6,580	6,510	−710	− 9.8
NGL & other hydrocarbons	1,606	1,600	1,630	1,660	1,690	1,720	1,750	+150	+ 9.4
Total liquids production	**9,219**	**8,820**	**8,660**	**8,480**	**8,370**	**8,300**	**8,260**	**−560**	**− 6.3**
Crude imports (ex. SPR)	5,788	6,250	6,550	7,050	7,405	7,705	7,985	+1,735	+27.8
Product imports	2,217	2,300	2,330	2,345	2,360	2,380	2,400	+100	+ 4.3
Total industry imports	**8,005**	**8,550**	**8,880**	**9,395**	**9,765**	**10,085**	**10,385**	**+1,835**	**+21.5**
Other supply	859	860	870	885	900	910	920	+60	+ 7.0
Total supply	**18,083**	**18,230**	**18,410**	**18,760**	**19,035**	**19,295**	**19,565**	**+1,335**	**+ 7.3**
TOTAL STOCKS:									
(million barrels) (year end)									
Crude stocks	341	345	350	355	360	365	370	+25	+ 7.2
Product stocks	660	695	705	720	730	740	750	+55	+ 7.9
Total industry stocks	**1,001**	**1,040**	**1,055**	**1,075**	**1,090**	**1,105**	**1,120**	**+80**	**+ 7.7**
SPR crude stocks	580	600	620	640	660	680	700	+100	+16.7
Total U.S. stocks	**1,581**	**1,640**	**1,675**	**1,715**	**1,750**	**1,785**	**1,820**	**+180**	**+11.0**
Industry stocks — days supply	57.8	60.2	60.2	60.2	60.1	60.1	60.1	− 0.1	− 0.2
IMPORT DEPENDENCY									
Net imports — % of domestic demand	41.2	44.7	45.9	47.9	49.1	50.1	51.0	6.3	+14.1
Total imports — % of domestic demand	46.2	49.5	50.7	52.6	53.8	54.9	55.7	+ 6.2	+12.5
Crude imports — % of crude supply	43.2	46.4	48.2	50.8	52.6	53.9	55.1	+ 8.7	+18.8
CRUDE OIL PRICE									
($/barrel)									
U.S. average wellhead	15.85	18.55	17.15	19.05	20.00	21.00	22.00	+3.45	+18.6
West Texas intermediate (posted)	18.25	21.35	19.75	21.90	23.00	24.15	25.30	+3.95	+18.5

CAPITAL EXPENDITURES

The conflict in the Middle East has resulted in much higher worldwide crude oil prices. This has also resulted in higher wellhead prices in the U.S. With higher prices the cash flow from production operations has also increased substantially. The revenue flowing into the industry is a key determinant of the level of incestment. Therefore the length of time that prices remain elevated should play a role in industry investment planning.

U.S. CAPITAL SPENDING

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
					(Million $)					
Drilling-Exploration	31,789	43,193	40,965	28,193	28,290	26,596	13,552	10,125	10,487	11,154
Production	6,191	7,984	7,144	5,531	5,590	5,217	3,066	2,046	2,088	2,256
OCS lease bonus	4,205	6,599	3,800	5,749	4,037	1,488	187	497	1,217	646
Subtotal	**42,185**	**57,776**	**51,909**	**39,473**	**37,917**	**33,301**	**16,805**	**12,668**	**13,792**	**14,056**
Refining	3,159	5,131	5,775	4,142	2,914	2,992	2,073	2,180	2,874	3,167
Petrochemicals	2,805	2,792	2,031	1,112	1,215	1,493	1,357	1,248	1,962	2,713
Marketing	1,276	1,619	1,349	1,614	2,221	2,611	1,634	1,810	2,525	2,613
Crude & products pipelines	1,777	2,052	1,121	2,456	1,689	1,137	435	733	400	451
Gas pipelines	3,642	4,947	5,179	4,707	3,971	2,084	1,309	1,556	1,659	959
Other transportation	804	895	515	456	386	458	380	310	416	498
Miscellaneous*	5,022	7,731	7,760	4,567	4,347	3,706	3,258	3,180	3,457	3,310
Subtotal	**18,485**	**25,167**	**23,730**	**19,054**	**16,743**	**14,481**	**10,446**	**11,017**	**13,293**	**13,721**
Total	**44,230**	**60,670**	**82,943**	**75,639**	**58,527**	**54,660**	**47,782**	**27,251**	**23,685**	**27,777**

*Includes mining and other energy

Source: Oil & Gas Journal

Investment in the U.S. oil and gas industry has gone through an extremely volatile period over the past 10–15 years. Capital and exploration expenditures in the oil and gas industry have taken some sharp swings over that period. The level of outlays has been closely tied to the amount of money flowing through the industry and the level of profitability. It has been most closely tied to the cash flow in the producing sector of the industry. And the cash flow has been determined to a great extent by the price level for crude oil and natural gas.

Prior to the 1970s there was relatively little price movement. Change in industry cash flow was determined by the change in the demand for crude, petroleum products and natural gas. And since this was an era of constantly rising demand, cash flow into the industry was tied to demand and also steadily rising. During this period, investment decisions were based upon the expectations of increasing demand. This was true of investment in the U.S. and throughout other areas of the world.

A change occurred in the 1970s. In the first part of the decade prices, demand and cash flow all moved up very rapidly. Capital expenditures followed and also moved up rapidly, particularly after the price hikes in the periods 1973–74 and 1978–80.

The biggest change from this historical trend came about following the latter increase in prices. Demand hit a peak in 1978 and started to slide. This was unprecedented in the industry. The industry did not recognize that demand had hit a peak and was still reacting to the huge jump in prices. Producers continued to push up prices and continued testing the market. Therefore, cash flow into the industry continued to move up. Capital expenditures followed prices and cash flow. But at that time, the increase was no longer tied to an industry with increasing demand.

Prices and capital spending did not peak until 1981. Both prices and spending exhibited a delayed reaction to the downturn in consumption of petroleum products.

U.S. oil and gas industry capital expenditures dropped continuously from 1980 through 1987, generally following the trend in crude oil and natural gas prices. However, another shift in direction may be occurring: capital outlays moved up slightly in 1988 on the strength of industry profits and a modestly optimistic outlook.

REVIEW

Over the past 10–15 years, the price of crude oil has led U.S. oil and gas industry capital expenditures through a cycle of huge ampli-

tude. For the industry it has been a boom-bust period of historic proportions.

THE RAPID RISE IN SPENDING. Starting in the late 1970s, rapidly rising prices led the way to a huge increase in investment. The average wellhead price of domestic crude oil went up from $9.00/bbl in 1978 to $31.77/bbl in 1981. This was a jump of $22.77/bbl, 253%, in just three years. The average cost of imported crude oil increased from $13.30/barrel in 1978 to $35.10/barrel in 1981, an increase of 163.9%. The average refiner acquisition cost of crude oil, both domestic and imported, increased from $12.46/barrel in 1978 to $35.24/barrel in 1981, an increase of 182.8%.

It should be noted that in 1978 there were still price controls on some domestic U.S. production, and therefore the average domestic price remained below the world price until controls were lifted in 1981.

Over this short three-year span the total value of U.S. crude production at the wellhead went up from $13.1 billion in 1973 to $28.6 billion in 1978. It then jumped to $99.4 billion in 1981. This came about even though U.S. crude production in 1981 was down 6.9% from 1973 and down 1.6% from 1978.

Based solely on wellhead value from domestic production, industry revenues had moved up $86.3 billion from 1973 and up $70.8 billion from three year earlier, 1978. When refined product sales are taken into consideration, the increased revenue is substantially greater. Product prices moved up along with crude prices, also substantially increasing the revenues flowing into the oil industry.

In response to this tremendous surge in revenue, industry capital spending shot up. Over the same three-year span, total U.S. oil industry capital spending went from $29.2 billion to $82.9 billion, an increase of 184.1%.

Over this upswing portion of the cycle, 1978 through 1981, exploration, drilling and production spending (including OCS lease bonus payments) increased from $20 billion to $57.8 billion, an increase of 189.2%. Spending on exploration and drilling activities alone increased from $15.1 billion in 1978 to $43.2 billion in 1981, an increase of 186.4%. Production outlays increased 154.9%, to $8.0 billion in 1981. And OCS lease bonus payments by the industry jumped to $6.6 billion in 1981, up from $1.8 billion in 1978.

With these lofty prices for crude oil and rising natural gas prices, there were many more production prospects that were economical for development. Even very marginally producing wells could be economically justified and considered potentially profitable.

Capital outlays were also being driven up by the expectations, at that time, of substantially higher price in future years. As a result of these optimistic projections, there was also a lot of additional outside capital flowing into exploration and production activity. With higher prices, the cash flow into the industry moved up, and this was combined with substantially more outside funds available for investing.

With adequate funds available, companies were also expanding and upgrading other aspects of their operations: refining, petrochemicals, marketing and transportation. In addition, some companies were diversifying into other industries, such as mining, and into other activities outside of natural resource development. Spending for all of the other segments of the industry also increased. Outlays for refining, marketing, transport, etc., moved up from $9.2 billion in 1978, to $25.2 billion in 1981, an increase of 173.2%.

THE DECLINE IN INDUSTRY INVESTMENTS.. Demand peaked in the U.S. in 1978 and prices peaked in March of 1981. These two events started a slide in industry investments that lasted for several years. The drop in prices and demand resulted in a large reduction in the cash flow into the U.S. oil and gas industry and therefore a reduction in the funds available for

U.S. CAPITAL SPENDING (CONSTANT DOLLARS)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
					(Million $)					
PPI*	**0.898**	**0.980**	**1.000**	**1.013**	**1.037**	**1.032**	**1.002**	**1.028**	**1.069**	**1.122**
Drilling & exploration	35,399.8	44,074.5	40,965.0	27,831.2	27,280.6	25,771.3	13,525.0	9,849.2	11,076.7	9,941.2
Production	6,894.2	8,146.9	7,144.0	5,460.0	5,390.5	5,055.2	3,059.9	1,990.3	2,173.1	2,010.7
OCS lease bonus	4,682.6	6,733.7	3,800.0	5,675.2	3,893.0	1,441.9	186.6	483.5	1,138.4	575.8
Subtotal	**46,976.6**	**58,955.1**	**51,909.0**	**38,966.4**	**36,564.1**	**32,268.4**	**16,771.5**	**12,323.0**	**14,388.2**	**12,527.7**
Refining	3,517.8	5,235.7	5,775.0	4,088.8	2,810.0	2,899.2	2,068.9	2,120.6	2,688.5	2,822.6
Petrochemicals	3,123.6	2,849.0	2,031.0	1,097.7	1,171.6	1,446.7	1,354.3	1,214.0	1,835.4	2,418.0
Marketing	1,420.9	1,652.0	1,349.0	1,593.3	2,141.8	2,530.0	1,630.7	1,760.7	2,362.0	2,328.9
Crude & prod. pipelines	1,978.8	2,093.9	1,121.0	2,424.5	1,628.7	1,101.7	434.1	713.0	374.2	402.0
Gas pipelines	4,055.7	5,048.0	5,179.0	4,646.6	3,829.3	2,019.4	1,306.4	1,513.6	1,551.9	863.6
Other transportation	895.3	913.3	515.0	450.1	372.2	443.8	379.2	301.6	389.1	443.9
Mining & other energy	5,592.4	7,888.8	7,760.0	4,508.4	4,191.9	1,200.6	1,274.5	1,195.5	1,089.8	788.8
Miscellaneous	0.0	0.0	0.0	0.0	0.0	2,390.5	1,977.0	1,897.9	2,144.1	2,161.3
Subtotal	**20,584.5**	**25,680.7**	**23,730.0**	**18,809.4**	**16,145.6**	**14,031.9**	**10,425.1**	**10,716.9**	**12,435.0**	**12,229.1**
Total	**67,561.1**	**84,635.8**	**75,639.0**	**57,775.8**	**52,709.7**	**46,300.3**	**27,196.6**	**23,039.9**	**26,823.2**	**24,756.8**

*Producer's Price Index (1982 = 1.00)

INTERNATIONAL SPENDING – U.S. FIRMS

	1983	1984	1985	1986	1987	1988	1989	1990	1991
					(Million $)				
Exploration-Production									
Drilling-Exploration	5,622	5,471	5,238	3,590	3,679	3,586	4,070	4,876	5,650
Production	2,940	2,706	2,688	2,322	2,472	3,020	3,355	4,125	4,820
Subtotal	**8,562**	**8,177**	**7,926**	**5,912**	**6,151**	**6,606**	**7,425**	**9,001**	**10,470**
Other									
Refining	696	795	959	716	471	822	967	1,016	1,120
Petrochemicals	346	438	245	360	436	589	725	818	830
Marketing	638	629	932	878	1,054	1,214	1,366	1,194	1,200
Pipelines	124	159	215	139	111	136	142	135	160
Other transportation	83	27	154	43	61	151	107	124	150
Mining & other energy	869	750	816	655	336	223	513	264	280
Miscellaneous	357	274	486	211	217	425	288	362	380
Subtotal	**3,113**	**3,072**	**3,807**	**3,002**	**2,686**	**3,560**	**4,108**	**3,913**	**4,120**
Total	**11,675**	**11,249**	**11,733**	**8,914**	**8,837**	**10,166**	**11,533**	**12,914**	**14,590**

Source: Oil & Gas Journal

capital and exploration spending.

As a result, U.S. oil and gas industry capital and exploration expenditures plummeted from the lofty levels of the 1981 and 1982 boom years. Capital spending by U.S. oil companies peaked in 1981 at $82.943 billion. It fell to $75.639 billion in 1982 and then dropped sharply to $58.527 billion in 1983. Spending dropped in 1984 to $54.660 billion and slipped again to $47.782 billion in 1985. Natural gas prices continued to move up until 1984 and provided a small offset to declining crude oil revenues, but this wasn't sufficient to stop the decline in cash flow.

When prices plummeted in 1986, capital spending followed, dropping precipitously to an estimated $27.251 billion. Prices moved up a bit in 1987, but investors were still wary of the crash the previous year. Capital spending slipped to $23.685 billion. Spending in 1987 was below the level of ten years earlier, 1977, when outlays totaled $26.691 billion. Spending in 1987 was down $59.258 billion from the peak in 1981.

Total spending moved up in 1988 for the first time since the 1981 peak year. A rise in oil prices in 1987 and increased profitability stimulated additional investment in 1988. Spending increased to $27.085 billion.

During the years of declining outlays, 1981–87, total exploration drilling and production outlays accounted for $45.1 billion of the decline. Spending in this sector of the business fell from $57.8 billion in 1981 to an estimated $12.7 billion in 1987. This was a drop of 78.1% in the six years. Outlays in this area fell $16.5 billion in 1986 alone.

Spending on other activities downstream also fell dramatically, but not as rapidly as exploration and production. All of the other capital spending together fell 56.2%, from $25.167 billion in 1981 to $11.017 billion in 1987, a drop of $14.150 billion.

Capital spending fell at about the same rate as crude prices. The average wellhead price of domestic crude oil fell from $31.77/bbl in 1981 to $12.51/bbl in 1986, a decline of 60.6%. Natural gas prices also began to fall in 1984 and the average wellhead price in 1986 was down 29.7% from the peak. Over this same period, there was also a drop in demand for petroleum products and natural gas, so the cash flow impact was greater than reflected in just the price change.

Crude prices moved up in 1987, slumped again in 1988 and then moved back up to $15.85/bbl in 1989. Natural gas prices continued to fall through 1987, down to $1.67/mcf. But they seemed to have bottomed out at that level and have moved up slightly, to $1.69/mcf in 1988 and $1.71/mcf in 1989. Crude production has been falling in 1988 and 1989, while natural gas production has been on the rise. With these trends there has not been any recent surge of cash into the industry that would stimulate a large increase in capital spending. Industry total capital spending did move up to $28,674 million in 1988, but then slipped to $27,777 million in 1989. Spending on exploration, drilling and production activities moved up to $15,381 million in 1988, but then dropped to $14,056 million in 1989.

OGJ GROUP* PROFITS AND CAPITAL SPENDING

	Net income ($ Million)	Capital & exploratory expenditures ($ Million)	Capital & exploration expenditures % of net income
1978	13,779.0	42,265.0	306.7
1979	23,130.0	53,261.0	230.3
1980	29,326.8	52,065.0	177.5
1981	28,205.4	66,895.8	237.2
1982	23,079.7	60,357.0	261.5
1983	22,325.5	45,584.1	204.2
1984	20,078.1	51,422.8	256.1
1985	15,801.5	50,907.5	322.2
1986	10,893.7	33,620.2	308.6
1987	8,370.4	32,079.3	383.2
1988	21,835.8	39,261.9	179.8
1989	18,881.0	41,916.8	222.0
Total 1978-1989	235,706.9	569,636.4	241.7

*Oil & Gas Journal group of 25-28 major oil companies.

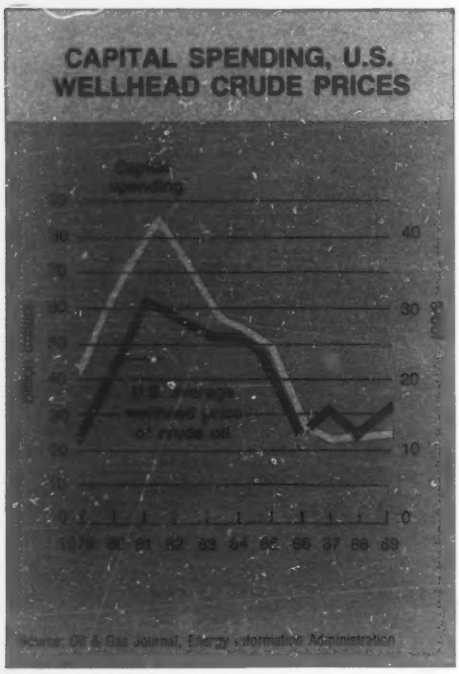
Source: Oil & Gas Journal

SPENDING AND PROFITS. Corporate investment decisions are probably made with a closer eye to profits than to prices. Although industry capital spending followed crude prices closely, the spending decisions were more probably based on estimated profitability. However, available funds also influence spending decisions. And crude and product prices were a major determinant of cash flow over the past ten years. So prices probably were also a major influencing factor in the investment decisions. Capital spending tended to follow cash flow, which was following the movement in prices and production.

The level of profits is determined by many factors. So although capital spending tends to follow profits, the relationship between the two in any given year can fluctuate greatly.

For the Oil & Gas Journal group of 25 large integrated oil companies, over the past 12 years, worldwide capital and exploration expenditures as a percentage of net income ranged from 177.5% in 1980 to 383.2% in 1987. The average from 1978 through 1989 was 241.6%.

The level of investment in any given year



was dependent upon the profit picture for the individual company at that point in time. It was also influenced by the available funds and the company's outlook for the industry. Overall, this group of companies has maintained a high level of capital investment relative to profits, despite the downturn in the industry. Their planning horizons tend to be relatively long-range and they invest for the future.

But with the low level of prices and the outside threat of takeovers recently, the companies have been forced to adhere more closely to the short-range market philosophy of the investment community. The longer-range outlook might pay larger future returns, but unfortunately many investors aren't looking very far into the future.

In addition, many oil companies have been forced into reorganization to prevent hostile takeovers and dismemberment. The fall in prices and oil company revenues rapidly changed the perception that outside investors had of the future potential of the oil industry. Outside interests saw a profit opportunity in forcing rapid restructuring. This has resulted in a wave of mergers, stock repurchase plans and other moves to fend off hostile takeovers. The result for many companies has been a substantial additional increase in debt, which has further reduced funds available for reinvestment.

In addition, companies have been restructuring since the peak period in other ways aimed at increasing profitability. They have been reducing staff levels, cutting operating costs and shedding surplus facilities. They have been somewhat preoccupied with these activities at the expense of new investing.

The exploration, drilling and production segments of the domestic industry have been particularly hard hit by the lower prices. The lower prices have markedly reduced the wellhead revenues from crude oil and natural gas production. This has diminished the funds available for reinvestment in drilling activity. In addition, many companies have had to use available funds to reduce the debt burden left over from the boom period.

During the boom, the expectation of higher oil prices not only increased the flow of outside capital, but also encouraged a number of companies to increase their debt to expand their operations. As prices fell, the debt became a prohibitive burden. The necessity to repay the debt with funds from lower-valued oil has severely restricted the investment capability of many firms.

Faced with falling oil prices and pessimistic future price prospects, the flow of outside capital into the industry dried up. The glamour left oil investing, and the highly speculative funds that had flowed into the industry in the 1979–82 period, in anticipation of a potential high rate of return, were being invested elsewhere.

As a result of the sharp drop in funds available to the industry, the wellhead revenue reinvestment ratio, an indicator of the attractiveness of oil investing, fell to one of the lowest lev-

WORLDWIDE PETROLEUM INDUSTRY CAPITAL SPENDING

	1986	1987	1988	1989	1990	1991
			(Million $)			
U.S. and Canada:						
Crude Oil and Natural Gas	29,150	23,940	28,320	24,920	26,650	31,300
NGL Plants	510	740	790	840	870	900
Refineries	2,950	3,050	3,290	3,690	4,560	4,800
Total North America	**32,610**	**27,730**	**32,600**	**29,450**	**32,080**	**37,000**
Mexico and Central and South America:						
Crude Oil and Natural Gas	6,930	6,180	6,125	4,695	4,510	4,900
Refineries	2,260	1,580	1,500	1,500	1,700	1,900
Total Central & S. America	**9,190**	**7,760**	**7,625**	**6,195**	**6,210**	**6,800**
Western Europe:						
Crude Oil and Natural Gas	11,550	12,030	13,115	11,540	11,900	13,500
Refineries	1,480	2,730	2,500	2,700	2,700	2,750
Total Western Europe	**13,030**	**14,760**	**15,615**	**14,240**	**14,600**	**16,250**
Middle East and Africa:						
Crude Oil and Natural Gas	3,160	2,770	2,915	2,790	3,070	3,500
Refineries	940	1,020	1,000	1,000	1,050	1,100
Total Middle East & Africa	**4,100**	**3,790**	**3,915**	**3,790**	**4,120**	**4,600**
Far East and Australasia:						
Crude Oil and Natural Gas	3,680	2,100	2,295	2,305	2,330	2,500
Refineries	1,860	2,040	2,000	2,050	2,100	2,150
LNG Plants	1,230	1,380	1,300	1,300	1,400	1,500
Total Far East & Australasia	**6,770**	**5,520**	**5,595**	**5,655**	**5,830**	**6,150**
Free World						
Crude Oil and Natural Gas	54,470	47,020	52,770	46,250	48,460	55,700
NGL Plants	510	740	790	840	870	900
Refineries	9,490	10,420	10,490	10,940	12,110	12,700
LNG Plants	1,230	1,380	1,300	1,300	1,400	1,500
Tankers	1,580	1,510	1,500	1,700	2,000	2,500
Total Free World	**67,280**	**61,070**	**66,850**	**61,030**	**64,840**	**73,300**

els on record. This ratio measures the percentage of total wellhead revenues that are reinvested in drilling activity. A drop in this ratio indicates a loss of confidence in investing in industry exploration.

Drilling rig activity followed the drop in the reinvestment ratio. Rig activity in 1986 fell to the lowest weekly level ever recorded, 663; at least the lowest level since the Hughes Tool Company started counting active rigs on a regular basis. The rig activity has remained low and averaged only 869 active rigs in 1989. That was the lowest level since the war effort depressed drilling activity in 1942.

It appears that a cycle in U.S. oil industry investment has been completed and the industry is back to about the point it started at in 1977. The average wellhead price for domestic crude was $15.41/bbl in 1987 and $15.85/bbl in 1989. U.S. crude prices were under some controls in 1977 and therefore are not a perfect comparison. Total capital and exploration spending in 1989 was $27.777 billion. Total spending in 1977 was $26.691 billion. The industry turned up in 1978 and there are presently some positive signs. However, any enthusiasm about the future has to be tempered since it is doubtful that there will be as rapid an increase in spending as there was ten years earlier.

NON-U.S. SPENDING. With the sharp drop in prices there has been a shift in investment spending to the lower-cost areas outside the U.S. In recent years the U.S. international companies have been spending a greater portion of their capital budgets outside the United States International spending by a group of U.S. companies has been on the rise since 1987. Spending outside the United States by this group has risen from $8.837 billion in 1987 to an estimated $11.533 billion in 1989 and $12.914 billion in 1990. This is an increase of 46.1% over the past three years. Plans call for this group to boost spending to $14.590 billion in 1991.

These companies are finding investments

in lower-cost non-U.S. areas to be more attractive than domestic investment. In addition, many non-OPEC countries are offering better investment terms to companies willing to explore in their country. When prices dropped, some of these countries saw investment in their oil industries dry up. The international companies did not find investing very profitable under the stringent financial terms that existed in past years.

Total worldwide petroleum industry capital spending fell off sharply after prices plummeted in 1986. Total investment fell from $91 billion in 1985 to $61.07 billion in 1987. When prices rebounded in 1987, it stimulated spending the following year and total capital spending increased to $66.85 billion in 1988. But prices fell in 1988 and spending dipped in response, to $61.03 billion in 1989. Spending for 1990 is estimated at $64.84 billion.

OUTLOOK

The conflict in the Middle East has resulted in much higher worldwide crude oil prices. The sharp reduction in worldwide crude oil supply pushed up the average price of world export crude oils 50% in the three weeks following the invasion. This has also resulted in higher wellhead prices in the United States. With higher prices the cash flow from production operations has also increased substantially.

The revenue flowing into the industry is a key determinant of the funds available and the ultimate level of investment. Therefore the length of time that prices remain elevated will play a major role in determining industry investment over the forecast period.

At this time it is uncertain how long the crisis involving Iraq and Kuwait will last. It is quite probable that the loss of this volume of crude oil will exert upward pressure on crude oil prices as long as the crisis continues. This makes it almost impossible to project with any certainty the most likely trend in investments over the forecast period.

Therefore, in this edition of the Oil Industry Outlook, three scenarios are being presented. The three scenarios vary in expectations of the length of time the crisis in the Persian Gulf will last. The length of time the oil crisis continues will determine the trend in the price of crude oil and therefore the trend in oil industry investment. To cover these variations three separate forecasts are presented. The forecast with the highest degree of probability is the one that comes closest to estimating the length of time it takes to finally resolve this issue in the Middle East, and for Iraqi and Kuwaiti oil to return to the market. Following is a brief review of the key points of each scenario. They are discussed in more detail in earlier chapters.

Scenario I—The embargo of oil exported from Iraq and Kuwait continues for a period of 6–18 months. The vast majority of oil production in Iraq and Kuwait is shut in for the duration of the dispute. Oil production capacity in other OPEC areas is not affected by the dispute. Following the settlement of the dispute, production in Iraq and Kuwait is resumed at previous levels.

Scenario II—The embargo of oil exported from Iraq and Kuwait continues for a period of 18–30 months. The vast majority of oil production in Iraq and Kuwait is shut in for the extended duration of the dispute. Oil production capacity in other OPEC areas is not affected by the dispute. Following the settlement of the dispute, production in Iraq and Kuwait is resumed at previous levels.

Scenario III—The embargo of oil exported from Iraq and Kuwait continues for less than six months. The vast majority of oil production in Iraq and Kuwait is shut in during this period. Production capacity in other OPEC countries is not affected by this dispute. Following settlement of the dispute, production in Iraq and Kuwait is resumed at previous levels.

The major differences between the three scenarios is the length of time that the crisis continues and Iraqi and Kuwaiti oil is off the market. But even though the length of time until settlement of the dispute is the only apparent difference, these three scenarios will cause three distinct sets of conditions in the oil market. And the different market conditions will create differing projections of price and level of investment over the forecast period, 1991–95.

The disruption of oil production and oil exports from Iraq and Kuwait has had an immediate impact on crude oil prices. And it is expected that the loss of this oil will tighten the market and place upward pressure on prices while the crisis lasts. Prices will fluctuate with seasonal demand because requirements for OPEC oil will come close to capacity during the periods of peak demand. As demand approaches capacity, prices will be bid up by refiners and traders looking for supplies to meet winter demand.

The outlook for the industry has been improving in recent years and that may mean the start of a new investment cycle. However, it is doubtful that the upswing portion of the cycle will be as volatile as the one that started ten years ago. Prices have been low and periodically have been depressed due to OPEC overproduction. Before the invasion, the most optimistic expectation was that prices would move up modestly over the forecast period. Demand for petroleum products was on the rise but competition from other fuels was holding down the rate of increase.

In addition, companies have been somewhat preoccupied with other concerns. The last few years have been a period of adjustment for the industry. It was necessary for most companies to restructure and cut costs sharply. This has led to a reduction in capital investment. It was not entirely certain when companies would start concentrating on future investments. However, the effects of the cost cutting are now beginning to show up in improved profits and some increased investments. In addition, as the companies reduce the heavy debt load brought on for restructuring, investment can be increased. Also the lower debt load and improved profits should attract additional outside funds into the industry.

No matter what the scenario, it is not expected that there will be anything close to the surge in spending that occurred during the 1980–82 period. Instead, capital expenditures will closely follow revenue and price movements, along with economic activity, and energy and oil demand. Capital spending in the U.S. oil and gas industry will move the way of prices and profits over the forecast period.

SCENARIO I—Total outlays are projected to be up 42.8% by 1995. Spending in 1995 will total $48.68 billion. This will be up $14.6 billion from 1990. The sharp increase in prices in 1991 will give a boost to investment in that year because of the additional funds available to the industry. When prices fall in 1992, spending is also expected to be lower. However, over the remainder of the forecast period, spending is expected to move up along with prices and demand. Over the forecast period, spending is expected to increase much faster than prices. Spending is at a relatively depressed level now so an increase to more normal levels will result in a faster growth rate. Domestic crude oil prices at the end of the forecast period are projected to be up 12.9% from 1990 but 35.6% over 1989. Natural gas prices will increase 31.4%, and motor gasoline pump prices will be up 8.5% from 1990 and 19.8% from 1989.

U.S. domestic expend tures for exploration and production activities will also tend to follow the movement of oil prices over the forecast period, but are expected to increase much faster. Spending in this sector of the domestic industry will increase sharply in 1991 but then decline slightly in 1992, when prices come back down. E&P spending will move up steadily over the remainder of the forecast period. The reinvestment ratio for the industry is quite low at present. Both cash flow into the industry and the percent-

age reinvested are expected to increase during the next five years. The annual level of spending on exploration, drilling, production and OCS lease bonuses is forecast to increase 67.4% over the five-year period. Spending will increase to $29.18 billion in 1995, up $11.746 billion from 1990.

Spending for just the exploration and drilling segment is projected to increase 65%, up $9.028 billion, to $22.925 billion in 1995. The expected price rise for crude oil and natural gas will stimulate drilling activity. And as prices move up, some outside investment funds will return to the industry. This will be particularly true in the later years if prices move up more rapidly.

The independent sector of the U.S. domestic industry does the majority of the drilling, but relies heavily on outside investment funds. When prices appear a bit more certain, investors will return and activity and investment by the independents is expected to increase. Some needed additional funds will flow in to increase exploration and drilling activity.

It may also become obvious in political circles that there is a necessity to replace depleting domestic oil and gas reserves. This may result in more favorable tax treatment for the industry. This would also give a boost to exploration and drilling activity as well as investment.

Spending on production facilities will follow drilling activity. Outlays will increase 83.8% over the forecast period, moving up to $5.305 billion in 1995.

Outer continental shelf (OCS) lease bonus payments will increase over the forecast period as the economics of the available offshore leases improves with the rising prices. The projection is for OCS bonus payments to rise to $950 million in 1995.

Spending on downstream facilities and other projects will not increase as rapidly over the forecast period, but spending will move up as higher prices make more funds available for investing. Outlays will increase 17.2%, to $19.5 billion in 1995. This is an increase of $2.856 billion.

Spending on refining facilities is expected to move up over the forecast period. Refiners will be investing to upgrade facilities, for reformulated gasoline production due to environmental concerns, for pollution cleanup and possibly some expansion. Annual refining capital expenditures are expected to increase to $4.665 billion in 1995. This would be an increase of 13.4% over 1990. A recent study by a consulting firm indicated that almost all gasoline may have to be reformulated by the year 2000. They estimated this process would cost refiners investments of $22 billion.

Investment in the petrochemical industry will concentrate on improving efficiency, reducing costs in the face of increasing foreign competition and increasing capacity as petrochemical demand grows with the economy. The petrochemical industry set record profits in 1988 and 1989, and sales were increasing markedly along with the growing economy. The growth has slowed but is expected to resume again during the forecast period. Spending for petrochemical facilities will move up to $3.145 billion in 1995, an increase of 16.5%. Total spending for refining and petrochemical operations is projected to increase 14.7%, to $7.81 billion in 1995.

Capital spending for marketing facilities is expected to continue to move up throughout most of the forecast period. Spending will slow slightly in 1992 when prices fall. The intense level of competition in the marketing sector has stimulated investment as companies strive to maintain and/or gain market share. Spending is expected to increase 9.9%, to $3.36 billion in 1995.

Transport spending for pipelines, tankers and trucks will increase 36.53% over the forecast period, moving up $1.183 billion to $4.4 billion in 1995.

Spending by U.S. oil companies for mining and other energy activities is expected to move up moderately over the forecast period. A number of companies have sold or discontinued their mining and metals operations but many are still investing in other energy. Outlays will increase

15.1%, to $990 million in 1995.

SCENARIO II—Total outlays are projected to be up 38.4% by 1995. Spending in 1995 will total $47.16 billion. This will be up $13.082 billion from 1990. The sharp increase in prices in 1991 and 1992 will give a boost to investment in those two years because of the additional funds available to the industry. When prices fall in 1993 spending is also expected to be lower. Over the remaining two years of the forecast period, spending is expected to move up along with prices and demand.

Over the forecast period, spending is expected to increase more than prices. Spending is at a relatively depressed level now so an increase to more normal levels results in a faster growth rate. Domestic crude oil prices at the end of the forecast period are projected to be up only 9.7% from 1990 but 31.9% over 1989. Natural gas prices will increase 28.6% and motor gasoline pump prices will be up 6.8% from 1990 and 17.9% from 1989.

U.S. domestic expenditures for exploration and production activities will also tend to follow the movement of oil prices over the forecast period but are expected to increase much faster. Spending in this sector of the domestic industry will increase sharply in 1991 and 1992 but then decline slightly in 1993 when prices come back down. E&P spending will move up over the remaining two years of the forecast period. The reinvestment ratio for the industry is quite low at present. Both cash flow into the industry and the percentage reinvested are expected to increase during the next five years. The annual level of spending on exploration, drilling, production and OCS lease bonuses is forecast to increase 60.1% over the five year forecast period. Spending will increase to $27.92 billion in 1995, up $10.486 billion from 1990.

Spending for just the exploration and drilling segment is projected to increase 57.8%, up $8.028 billion, to $21.925 billion in 1995. The expected price rise for crude oil and natural gas will stimulate drilling activity. And as prices move up, some outside investment funds will return to the industry, particularly in 1992.

The independent sector of the U.S. domestic industry does the majority of the drilling, but relies heavily on outside investment funds. When prices appear a bit more certain or are substantially higher, investors will return and activity and investment by the independents is expected to increase. Some needed additional funds will flow in to increase exploration and drilling activity. It may also become obvious in political circles that there is a necessity to replace depleting domestic oil and gas reserves. This may result in more favorable tax treatment for the industry. This would also give a boost to exploration and drilling activity as well as investment.

Spending on production facilities will follow drilling activity. Outlays will increase 75.8% over the forecast period, moving up to $5.075 billion in 1995.

Outer continental shelf (OCS) lease bonus payments will increase over the forecast period as the economics of the available offshore leases improves with the rising prices. The projection is for OCS bonus payments to rise to $920 million in 1995.

Spending on downstream facilities and other projects will not increase as rapidly over the forecast period, but spending will move up as higher prices make more funds available for investing. Outlays will increase 15.6%, to $19.24 billion in 1995. This is an increase of $2.596 billion.

Spending on refining facilities is expected to move up over the forecast period. Refiners will be investing to upgrade facilities, for reformulated gasoline production due to environmental concerns, for pollution cleanup and possibly some expansion. Annual refining capital expenditures are expected to increase to $4.6 billion in 1995. This would be an increase of 11.9% over 1990. A recent study by a consulting firm indicated that almost all gasoline may have to be reformulated

by the year 2000. They estimated that this process would cost refiners investments of $22 billion.

Investment in the petrochemical industry will concentrate on improving efficiency, reducing costs in the face of increasing foreign competition, and increasing capacity as petrochemical demand grows with the economy. The petrochemical industry set record profits in 1988 and 1989, and sales were increasing markedly along with the growing economy. The growth has slowed but is expected to resume again during the forecast period. Spending for petrochemical facilities will move up to $3.105 billion in 1995, an increase of 15%. Total spending for refining and petrochemical operations is projected to increase 13.1%, to $7.705 billion in 1995.

Capital spending for marketing facilities is expected to continue to move up throughout most of the forecast period. It will slow in 1993 when prices decline. The intense level of competition in the marketing sector has stimulated investment as companies strive to maintain and/or gain market share. Spending is expected to increase 8.5%, to $3.315 billion in 1995.

Transport spending for pipelines, tankers and trucks will increase 34.8% over the forecast period, moving up $1.128 billion, to $4.365 billion in 1995.

Spending by U.S. oil companies for mining and other energy activities is expected to be up moderately over the forecast period. A number of companies have sold or discontinued their mining and metals operations but many are still investing in other energy. Outlays will increase 13.4%, to $975 million in 1995.

SCENARIO III—Total outlays are projected to be up 47.2% by 1995. Spending in 1995 will total $49.665 billion. This will be up $15.942 billion from 1990. The sharp increase in prices in 1990 will give only a small boost to investment in the next year because of the additional funds available to the industry. Over the forecast period, spending is expected to move up along with prices and demand. Spending is expected to increase much faster than prices. Spending is at a relatively depressed level now so an increase to more normal levels will result in a faster growth rate. Domestic crude oil prices at the end of the forecast period are projected to be up 18.6% from 1990 and 38.8% over 1989. Natural gas prices will increase 37.1%, and motor gasoline pump prices will be up 13% from 1990 and 22.6% from 1989.

U.S. domestic expenditures for exploration and production activities will also tend to follow the movement of oil prices over the forecast period but are expected to increase much faster. E&P spending will move up steadily over the forecast period. The reinvestment ratio for the industry is quite low at present. Both cash flow into the industry and the percentage reinvested are expected to increase during the next five years. The annual level of spending on exploration, drilling, production and OCS lease bonuses is forecast to increase 72.6% over the five-year forecast period. Spending will increase to $29.945 billion in 1995, up $12.596 billion from 1990.

Spending for just the exploration and drilling segment is projected to increase 70.1%, up $9.703 billion, to $23.53 billion in 1995. The expected price rise for crude oil and natural gas will stimulate drilling activity. And as prices move up, some outside investment funds will return to the industry. This will be particularly true in the later years if prices move up more rapidly.

The independent sector of the U.S. domestic industry does the majority of the drilling, but relies heavily on outside investment funds. When prices appear a bit more certain, investors will return and activity and investment by the independents is expected to increase. Some needed additional funds will flow in to increase exploration and drilling activity.

It may also become obvious in political circles that there is a necessity to replace depleting domestic oil and gas reserves. This may result in more favorable tax treatment for the industry. This would also give a boost to exploration and drilling activity as well as investment.

Spending on production facilities will follow drilling activity. Outlays will increase 89.6% over the forecast period, moving up to $5.445 billion in 1995.

Outer continental shelf (OCS) lease bonus payments will increase over the forecast period as the

economics of the available offshore leases improves with the rising prices. The projection is for OCS bonus payments to rise to $970 million in 1995.

Spending on downstream facilities and other projects will not increase as rapidly over the forecast period, but spending will move up as higher prices make more funds available for investing. Outlays will increase 20.4%, to $19.72 billion in 1995. This is an increase of $3.346 billion.

Spending on refining facilities is expected to move up over the forecast period. Refiners will be investing to upgrade facilities, for reformulated gasoline production due to environmental concerns, for pollution cleanup and possibly some expansion. Annual refining capital expenditures are expected to increase to $4.72 billion in 1995. This would be an increase of 17.9% over 1990. A recent study by a consulting firm indicated that almost all gasoline may have to be reformulated by the year 2000. They estimated that this process would cost refiners investments of $22 billion.

Investment in the petrochemical industry will concentrate on improving efficiency, reducing costs in the face of increasing foreign competition, and increasing capacity as petrochemical demand grows with the economy. The petrochemical industry set record profits in 1988 and 1989 and sales were increasing markedly along with the growing economy. The growth has slowed but is expected to resume again during the forecast period. Spending for petrochemical facilities will move up to $3.18 billion in 1995, an increase of 17.6%. Total spending for refining and petrochemical operations is projected to increase 17.8%, to $7.9 billion in 1995.

Capital spending for marketing facilities is expected to continue to move up throughout most of the forecast period. The intense level of competition in the marketing sector has stimulated investment as companies strive to maintain and/or gain market share. Spending is expected to increase 13.5%, to $3.4 billion in 1995.

Transport spending for pipelines, tankers and trucks will increase 41.3% over the forecast period, moving up $1.307 billion, to $4.47 billion in 1995.

Spending by U.S. oil companies for mining and other energy activities is expected to move up moderately over the forecast period. A number of companies have sold or discontinued their mining and metals operations but many are still investing in other energy. Outlays will increase 19.5%, to $1 billion in 1995.

In the exploration and production sector, some of the larger international companies are shifting a large proportion of their spending overseas. A sampling of spending plans for a group of U.S. companies shows international expenditures will be up 13% in 1991, to $14.59 billion. Exploration drilling and production outlays are projected to be up 16.3%, at $9.001 billion.

This is indicative of an expected shift to more investment in international activities. With lower cost, more profitable exploration and production activity possible overseas, U.S. international companies are diverting more of their investments to overseas operations than in past years. With higher prices possibly for the next year or two, there will be additional funds available for investing. It has been possible for the companies to negotiate some attractive exploration agreements in some of the non-OPEC producing countries. Overseas downstream investments will not move up as rapidly. The worldwide industry already has some excess capacity in refining and petrochemicals, and new facilities in the Middle East have further added to the problem. Some investment could be shifted from U.S. domestic activities to the international scene, but the funds will be selectively invested in the most profitable sectors of the business.

Total spending by the worldwide petroleum industry is projected to move up in 1991 in anticipation of future profit improvement in the industry. Total spending is projected to be up 13.%, an increase of $8.46 billion, to $73.3 billion for 1991.

Upstream spending is expected to move up 14.9%, to $55.7 billion.

CAPITAL EXPENDITURES KEYS TO THE FUTURE SCENARIO I

1. Increased prices for crude oil, natural gas and petroleum products coupled with increased demand will give a substantial boost to industry cash flow. Investments will jump up in 1991 due to the higher prices that year. However, prices will fall in 1992 after the Middle East dispute is settled, and industry spending will fall. Spending will move up over the remainder of the forecast period as prices climb along with energy demand.

2. Exploration and drilling expenditures will move up faster than prices as the economics of drilling improve. Some outside money will flow back into the industry, due to the improved profitability. The jump in prices in 1991 will boost E&P spending by U.S. independents. Outlays will fall in 1992 but then move up over the remainder of the forecast period. Exploration and drilling spending will be 65% higher in 1995.

3. Increased cash flow and higher industry profits will lead to increased investment in the downstream sectors. Investment in refining and petrochemical facilities will move up over the forecast period. Upgrading and some capacity additions will be required. Refining spending will be 13.4% higher in 1995. Petrochemical investment will be up 16.5%.

4. As demand for crude oil and natural gas moves up over the forecast period, additional investment will be required in transportation equipment and pipelines. There will also be additional investment required because of environmental concerns. Transportation spending will be 36.5% higher in 1995.

5. Some U.S. international companies will shift a greater portion of their investment overseas, to take advantage of attractive international exploration and drilling opportunities. Higher prices in 1991 will encourage these companies also to boost spending overseas.

6. Higher prices and increased demand will boost worldwide oil industry spending substantially at the start of the forecast period. It will continue to move up over the five years due to the increased energy requirements.

THE OUTLOOK — CAPITAL EXPENDITURES
SCENARIO — I

	1989	1990	1991	1992	1993	1994	1995	Change 1990 to 1995	% change 1990 to 1995
U.S. DOMESTIC OIL INDUSTRY CAPITAL EXPENDITURES									
(Million $)									
Exploration & drilling	11,923	13,897	16,900	16,230	18,070	20,240	22,925	+9,028	+ 65.0
Production	2,408	2,887	3,510	3,465	3,965	4,560	5,305	+2,418	+ 83.8
OCS lease bonuses	646	650	995	770	830	890	950	+300	+46.2
Subtotal	**14,977**	**17,434**	**21,405**	**20,465**	**22,865**	**25,690**	**29,180**	**+11,746**	**+ 67.4**
Refining	3,167	4,112	4,625	4,340	4,450	4,565	4,665	+553	+13.4
Petrochemicals	2,713	2,699	2,725	2,790	2,885	3,005	3,145	+446	+16.5
Marketing	2,613	3,056	3,260	3,160	3,230	3,275	3,360	+304	+ 9.9
Pipelines	1,420	2,538	2,840	2,900	2,995	3,055	3,135	+597	+23.5
Other transportation	498	699	865	970	1,085	1,185	1,285	+586	+83.8
Mining and other energy	885	860	875	830	890	935	990	+130	+15.1
Miscellaneous	2,425	2,680	2,740	2,740	2,815	2,865	2,920	+240	+ 9.0
Subtotal	**13,721**	**16,644**	**17,930**	**17,730**	**18,350**	**18,885**	**19,500**	**+2,856**	**+17.2**
Total	**28,698**	**34,078**	**39,335**	**38,195**	**41,215**	**44,575**	**48,680**	**+14,602**	**+42.8**
OFFSHORE SPENDING:									
(Million $)									
Exploration-Drilling-Production	4,242	5,002	6,080	5,900	6,610	7,450	8,500	+3,498	+69.9
PRICES:									
Crude oil	15.85	19.05	23.80	18.60	19.55	20.50	21.50	+2.45	+12.9
(Av. U.S. wellhead—$/barrel)									
Natural gas	1.71	1.75	1.85	2.00	2.10	2.20	2.30	+0.55	+31.4
(Av. U.S. wellhead—$/mcf)									
Motor gasoline	1.06	1.17	1.40	1.15	1.17	1.22	1.27	+0.10	+ 8.5
(Av. all types—$/gallon)									

CAPITAL EXPENDITURES KEYS TO THE FUTURE SCENARIO II

1. Increased prices for crude oil, natural gas and petroleum products coupled with increased demand will give a substantial boost to industry cash flow. Investments will jump up in 1991 and 1992 due to the higher prices that year. However, prices will fall in 1993 after the Middle East dispute is settled, and industry spending will fall. Spending will move up over the remainder of the forecast period as prices climb along with energy demand.

2. Exploration and drilling expenditures will move up faster than prices as the economics of drilling improve. Some outside money will flow back into the industry, due to the improved profitability. The jump in prices in 1991 and 1992 will boost E&P spending by U.S. independents. Outlays will fall in 1993 but then move up the last two years of the forecast period. Exploration and drilling spending will be 57.8% higher in 1995 than 1990.

3. Increased cash flow and higher industry profits will lead to increased investment in the downstream sectors. Investment in refining and petrochemical facilities will move up over the forecast period. Upgrading and some capacity additions will be required. Refining investment will be 11.9% higher in 1995 than in 1990. Petrochemical spending will be up 15%.

4. As demand for crude oil and natural gas moves up over the forecast period, additional investment will be required in transportation equipment and pipelines. There will also be additional investment required because of environmental concerns. Transportation investment will be 34.8% higher in 1995.

5. Some U.S. international companies will shift a greater portion of their investment overseas, to take advantage of attractive international exploration and drilling opportunities. Higher prices in 1991 and 1991 will encourage these companies also to boost spending overseas.

6. Higher prices and increased demand for energy will boost worldwide oil industry spending substantially at the start of the forecast period. It will continue to move up over the five years due to the increased energy requirements.

THE OUTLOOK — CAPITAL EXPENDITURES
SCENARIO — II

	1989	1990	1991	1992	1993	1994	1995	Change 1990 to 1995	% change 1990 to 1995
U.S. DOMESTIC OIL INDUSTRY CAPITAL EXPENDITURES									
(Million $)									
Exploration & drilling	11,923	13,897	16,900	20,315	16,370	18,785	21,925	+ 8,028	+ 57.8
Production	2,408	2,887	3,510	4,340	3,595	4,235	5,075	+2,188	+ 75.8
OCS lease bonuses	646	650	995	1,085	770	845	920	+270	+41.5
Subtotal	**14,977**	**17,434**	**21,405**	**25,740**	**20,735**	**23,865**	**27,920**	**+10,486**	**+ 60.1**
Refining	3,167	4,112	4,625	5,090	4,285	4,455	4,600	+488	+11.9
Petrochemicals	2,713	2,699	2,725	3,000	2,780	2,930	3,105	+406	+15.0
Marketing	2,613	3,056	3,260	3,585	3,110	3,195	3,315	+259	+ 8.5
Pipelines	1,420	2,538	2,840	3,125	2,885	2,980	3,095	+557	+21.9
Other transportation	498	699	865	1,050	1,050	1,160	1,270	+571	+81.7
Mining and other energy	885	860	875	925	860	915	975	+115	+13.4
Miscellaneous	2,425	2,680	2,740	3,015	2,710	2,795	2,880	+200	+ 7.5
Subtotal	**13,721**	**16,644**	**17,930**	**19,790**	**17,680**	**18,430**	**19,240**	**+2,596**	**+15.6**
Total	**28,698**	**34,078**	**39,335**	**45,530**	**38,415**	**42,295**	**47,160**	**+13,082**	**+38.4**
OFFSHORE SPENDING:									
(Million $)									
Exploration-Drilling-Production	4,242	5,002	6,080	7,345	6,000	6,920	8,130	+3,128	+62.5
PRICES:									
Crude oil	15.85	19.05	23.80	26.20	18.10	19.50	20.90	+1.85	+ 9.7
(Av. U.S. wellhead—$/barrel)									
Natural gas	1.71	1.75	1.85	2.00	1.95	2.10	2.25	+0.50	+28.6
(Av. U.S. wellhead—$/mcf)									
Motor gasoline	1.06	1.17	1.40	1.50	1.15	1.20	1.25	+0.08	+ 6.8
(Av. all types—$/gallon)									

CAPITAL EXPENDITURES KEYS TO THE FUTURE SCENARIO III

1. Increased prices for crude oil, natural gas and petroleum products coupled with increased demand will give a boost to industry cash flow. The higher prices at the end of 1990 will give only a small boost to spending. Prices will fall in 1991 after the Middle East dispute is settled. Spending will move up over the forecast period as prices climb along with energy demand.

2. Exploration and drilling expenditures will move up faster than prices as the economics of drilling improve. Some outside money will flow back into the industry, due to the improved profitability. The jump in prices in 1990 will give a modest boost to E&P spending by U.S. independents. Exploration and drilling spending will be 70% higher in 1995.

3. Increased cash flow and higher industry profits will lead to increased investment in the downstream sectors. Investment in refining and petrochemical facilities will move up over the forecast period. Upgrading and some capacity additions will be required. Refining spending will be 17.9% higher in 1995 than in 1990. Petrochemical spending will be 17.6% higher.

4. As demand for crude oil and natural gas moves up over the forecast period, additional investment will be required in transportation equipment and pipelines. There will also be additional investment required because of environmental concerns. Transportation spending will be 41.3% higher in 1995 than in 1990.

5. Some U.S. international companies will shift a greater portion of their investment overseas, to take advantage of attractive international exploration and drilling opportunities. The higher prices in 1990 will also encourage these companies to boost spending overseas.

6. Higher prices and increased demand will boost worldwide oil industry spending at the start of the forecast period. It will continue to move up over the five years due to the increased energy requirements.

THE OUTLOOK — CAPITAL EXPENDITURES
SCENARIO — III

	1989	1990	1991	1992	1993	1994	1995	Change 1990 to 1995	% change 1990 to 1995
U.S. DOMESTIC OIL INDUSTRY CAPITAL EXPENDITURES									
(Million $)									
Exploration & drilling	11,923	13,827	14,430	16,725	18,515	20,800	23,530	+ 9,703	+ 70.1
Production	2,408	2,872	2,995	3,575	4,065	4,690	5,445	+2,573	+ 89.6
OCS lease bonuses	646	650	715	790	850	910	970	+320	+49.2
Subtotal	**14,977**	**17,349**	**18,140**	**21,090**	**23,430**	**26,400**	**29,945**	**+12,596**	**+ 72.6**
Refining	3,167	4,004	4,280	4,390	4,500	4,620	4,720	+716	+17.9
Petrochemicals	2,713	2,704	2,750	2,830	2,920	3,040	3,180	+476	+17.6
Marketing	2,613	2,996	3,100	3,200	3,270	3,330	3,400	+404	+13.5
Pipelines	1,420	2,482	2,740	2,970	3,030	3,100	3,170	+688	+27.7
Other transportation	498	681	800	1,000	1,100	1,200	1,300	+619	+90.9
Mining and other energy	885	837	850	850	900	950	1,000	+163	+19.5
Miscellaneous	2,425	2,670	2,730	2,800	2,850	2,900	2,950	+280	+10.5
Subtotal	**13,721**	**16,374**	**17,250**	**18,040**	**18,570**	**19,140**	**19,720**	**+3,346**	**+20.4**
Total	**28,698**	**33,723**	**35,390**	**39,130**	**42,000**	**45,540**	**49,665**	**+15,942**	**+47.2**
OFFSHORE SPENDING:									
(Million $)									
Exploration-Drilling-Production	4,242	4,977	5,210	6,080	6,775	7,660	8,720	+3,743	+75.2
PRICES:									
Crude oil	15.85	18.55	17.15	19.05	20.00	21.00	22.00	+3.45	+18.6
(Av. U.S. wellhead—$/barrel)									
Natural gas	1.71	1.75	1.90	2.05	2.15	2.30	2.40	+0.65	+37.1
(Av. U.S. wellhead—$/mcf)									
Motor gasoline	1.06	1.15	1.10	1.15	1.20	1.25	1.30	+0.15	+13.0
(Av. all types—$/gallon)									

EXPLORATION, DRILLING AND PRODUCTION

The recent upheaval in the Middle East has resulted in a sharp increase in crude oil prices. There is no indication at the present time of how long this dispute will last. And therefore there is no way of telling how long this new higher price level will continue.

Higher crude oil prices would give a significant boost to exploration and drilling activity in the U.S. and throughout the producing areas of the world. If this

dispute and the accompanying higher price level lasts for an extended period, it should also show up in increased exploration, drilling and production investment and activity.

The exploration, drilling and production sector of the U.S. oil and gas industry has been languishing in the trough of its most recent activity cycle for the last four years. Activity levels in exploration and drilling are at all-time lows. But extreme cycles in activity seem to be the norm rather than the exception for the exploration and drilling sector of the U.S. oil and gas industry.

This sector of the industry has gone through some extreme cycles during its history. But none of the previous cycles was as pronounced as the present one. During this cycle, exploration and drilling activity in the U.S. went through both a record high level of activity and hit a record low. And the time span from record high to record low was only a short period of 4.5 years.

Activity in this area of the industry has closely followed the price of crude oil and natural gas. The relationship between activity and price has been closer in this sector than in any other segment of the industry. Therefore this jump in prices could be a new boost for E&P activities.

This segment of the industry has been amazingly adept at rapidly adjusting to shifts in economic conditions. At the present it is difficult to determine if the industry is poised at the start of a new upward leg of another cycle or is caught in an extended trough. There have been modest signs of recovery but there have also been indications of a continued recession in activity.

One thing that is certain is that crude oil and natural gas will be major energy sources for a long time into the future. And exploration and drilling are the only way to find new domestic reserves.

REVIEW

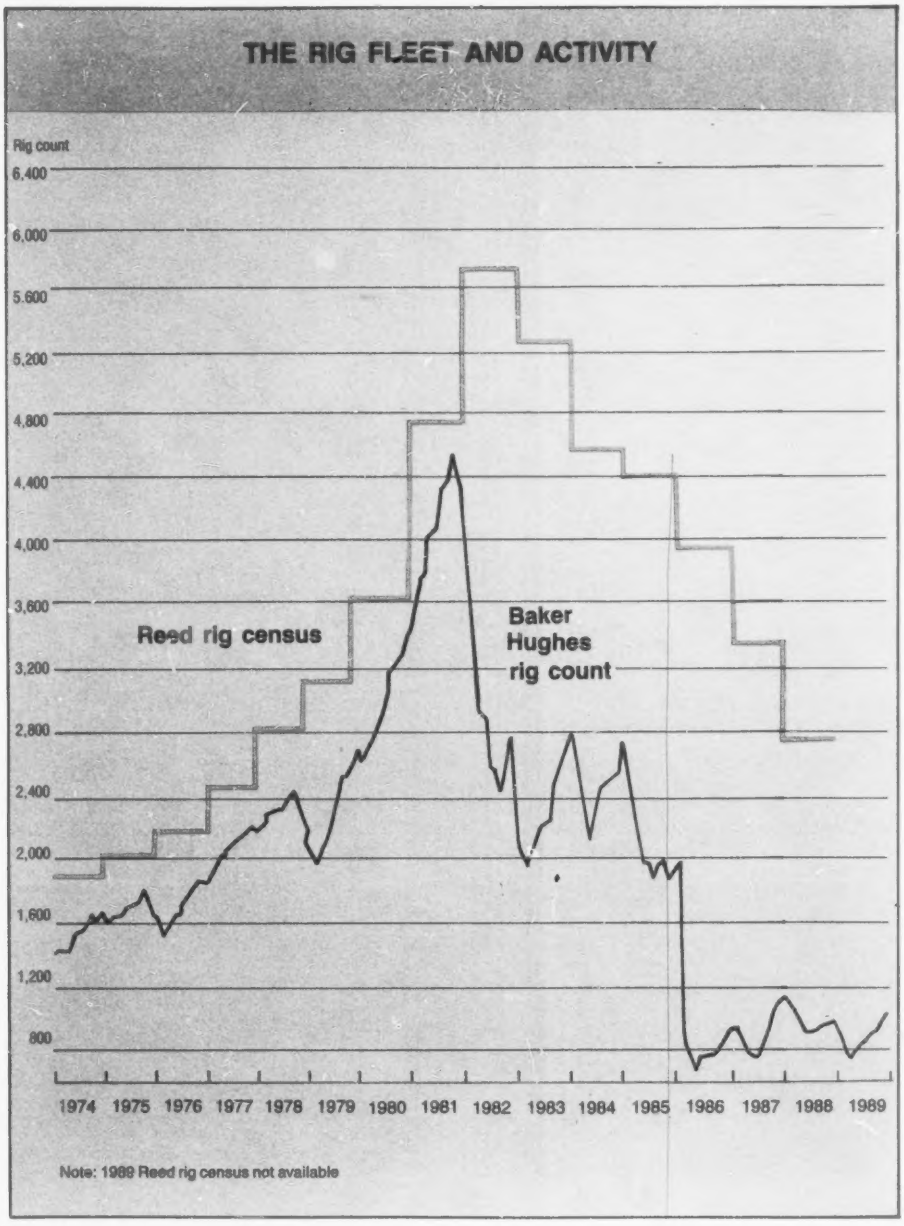
RIG ACTIVITY. The number of active rotary drilling rigs is a key indicator of activity in the upstream portion of the U.S. domestic oil and gas industry. Through the recent boom and bust cycle the number of active drilling rigs has closely followed the price of crude oil. And it appears that this close relationship will continue for the foreseeable future.

When the price of crude oil moved up rapidly between 1971 and 1981, the rig count followed. The number of active rotary drilling rigs increased from an annual average of 976 rigs in 1971 to a peak of an average of 3,970 rigs in 1981. This was an increase of 2,994 active rigs, 306.8%. The amount of domestic drilling activity quadrupled over that eleven-year span. The record active rig count for any one week was reached the last week of December 1981, at 4,530 active rotary rigs.

During that period the rig count was chasing the rapidly increasing price of oil. Back in 1971, the average U.S. wellhead price for crude oil was $3.39/bbl. This moved up sharply in the 1970s and reached a high of $34.70/bbl in March 1981. At that lofty price almost any producing well was considered economic and therefore drilling activity rapidly increased.

But prices began to slip after March 1981. There was not an immediate response in rig activity, but starting in January 1982 the rig count finally followed. And the rig count fell precipitously. The active rig count fell for ten consecutive months, hitting a 1982 low of 2,379 in October, and averaging 3,105 active rigs for the year. There was a slight seasonal upturn at the end of the year, but then the count continued its decline. The number of active rigs fell to 1,807 in April 1983. This was down 2,723 active rigs from the peak, a drop of 60.1% in rig activity. The annual average for 1983 was 2,232 active rigs, down 1,738 rigs from the annual average peak, a drop of 43.8%.

Prices seemed to stabilize at around $26/bbl in 1984. And as a result there was a slight upturn in rig activity in 1984. The rig count averaged 2,428 for the year. But the price of crude oil slid further in 1985, to $24/bbl, and the rig count



also fell, averaging 1,980 for the year, down 18.5% from the previous year. The rig count that year was down 50% from the top year in 1981.

Excess worldwide production brought about a precipitous crash in crude prices in 1986. And this resulted in a sharp drop in the active rig count, falling to a record low. The rig count had averaged 1,950 active rigs in the month of Decem-

WELL COMPLETIONS, FOOTAGE, AND ACTIVE RIGS

	Active rigs	Total well completions*	Total footage*	Average ft. well	Avg. wells per rig	Avg. ft. per rig
1974	1,471	33,037	153,776,399	4,655	22.46	104,539
1975	1,660	38,884	181,039,993	4,656	23.42	109,060
1976	1,656	40,940	187,289,586	4,575	24.72	113,098
1977	2,001	45,855	215,695,878	4,704	22.92	107,794
1978	2,255	50,061	238,386,248	4,762	22.20	105,715
1979	2,176	51,890	243,685,430	4,696	23.85	111,988
1980	2,910	69,486	311,444,837	4,482	23.88	107,026
1981	3,970	89,234	406,520,453	4,556	22.48	102,398
1982	3,105	83,889	375,382,919	4,475	27.02	120,896
1983	2,232	75,738	316,617,464	4,180	33.93	141,854
1984	2,428	85,359	368,336,310	4,315	35.16	151,704
1985	1,980	70,806	316,778,000	4,474	35.76	159,989
1986	964	39,118	177,977,000	4,550	40.58	184,623
1987	937	35,732	162,101,000	4,537	38.18	173,185
1988	937	34,015	158,883,000	4,671	36.30	169,566
1989	870	30,401	137,492,000	4,523	34.94	158,037

*Excludes service and stratigraphic wells and core tests.

Source: American Petroleum Institute and Baker Hughes Inc.

ber 1985. With the crude oil price in a "free fall" the rig count took a precipitous dive, dropping to a record average monthly low of 686 active rigs in July 1986. The record weekly low was recorded July 14, 1986, at 663 rigs. From the record high in December 1981, this was a drop of 3,867 active rigs, 85.4%, in 54 months. The year ended with the lowest annual average rig count since 1942, at 964 active rigs. In 1942 the count was depressed because manufacturing activities were focused almost solely on producing for the military effort.

Crude oil prices dipped below $10/bbl in 1986. The low point was July 1986 when the average wellhead price for U.S. crude oil hit $9.25/bbl. For the year, prices averaged $12.51/bbl, down 48.1% from the previous year, and down 60.6% from the peak year.

The decline in crude oil prices was the main reason for the sharp drop in rig activity. But there were a couple of factors that contributed to the magnitude of the decline.

Not only did prices begin to slide in 1981, but by the next year, the long-range outlook for oil prices had changed dramatically. During the expansion phase of the boom, projections called for oil prices to move up to $50/bbl and higher in the near future. And a lot of the investment was based on these price expectations. This outlook prevailed for some time even after prices had begun to fall.

Prices turned around in February and March 1981. The U.S. refiner acquisition cost of imported crude peaked in February 1981 at $39/bbl. Domestic refiner acquisition cost and wellhead price peaked in March 1981, at $36.97 and $34.70, respectively. Analysts were not immediately aware of the turnaround or did not recognize it as a turning point. Aggregate price data prepared by the government was not immediately available to warn of the change in direction in crude oil prices. It often takes 3–5 months for government agencies to collect, aggregate and publish this information.

At that early date few analysts or investors picked up on the implications of the early 1981 drop in prices. Any leveling of prices was considered temporary or regional. And, at the prevailing prices, even though slightly lower, many projects were still very attractive. So the drilling boom continued throughout 1981 and into 1982, even as crude prices fell.

As prices continued the slide, prospects diminished substantially for any future appreciation of the value of crude oil—at least for the most immediate future period that is used for making investment decisions. Therefore, outside investments declined. Part of the boom had been financed by speculative investing, which tends to chase the highest expected rate of return. With the drop in prices and a pessimistic outlook, much of that investment money fled from the petroleum industry.

Another reason for the rapid and extremely deep cut in drilling activity was the accumulation of debt by oil operators and producers. Expectations that crude oil prices would reach $50/bbl and continue to climb had stimulated the surge in drilling activity. With an industry consensus supporting this outlook for higher prices, investment funds flowed into the drilling industry, and banks actively sought investors in oil exploration projects. Funds were available and the "expert" analysis supported investment, even if it

U.S. PRODUCING WELLS

	1981	1982	1983	1984	1985	1986	1987	1988	1989
Well completions:									
Oil wells	42,520	39,252	37,396	44,472	36,458	18,598	16,441	14,056	11,123
Gas wells	19,742	18,810	14,505	14,962	12,917	8,055	8,114	8,697	9,708
Net abandonments:									
Oil wells	37,763	16,119	14,248	26,955	10,639	36,534	24,950	21,789	20,206
Gas wells	2,907	6,896	3,306	3,061	3,426	9,872	416	643	5,848
	40,670	**23,015**	**17,554**	**30,016**	**14,065**	**46,406**	**25,101**	**22,432**	**26,054**
Producing wells: (Dec. 31)									
Oil wells	557,009	580,142	603,290	620,807	646,626	628,690	620,181	612,448	603,365
Gas wells	198,839	210,753	221,952	233,853	243,344	241,527	249,225	257,279	261,139
	755,848	**790,895**	**825,242**	**854,660**	**889,970**	**870,217**	**869,406**	**869,727**	**864,504**

Source: API, abandonments calculated by author

required substantial debt. Everyone wanted to drill as many prospects as possible, as fast as possible, and many companies borrowed the needed funds and became burdened with debt.

When prices fell, funds had to be diverted to handle the debt. The result was a sharper drop in activity than would have been otherwise warranted by the basic economics. Actually the economics of drilling improved during the 1982–85 period. Drilling costs fell faster than crude prices during this period. But many companies were unable to take advantage of this situation because of the debt burden they had accumulated during the boom.

The rig count fell to a record monthly and weekly low in July 1986, and then rebounded slightly toward the end of that year. But the recovery was rather weak and rig activity has remained depressed ever since 1986. Although crude prices also rebounded at the end of 1986 and remained at the higher level in 1987, the industry was wary of future drilling prospects. The price crash of 1986 left them quite skeptical. Drilling activity was very sluggish during the first half of 1987. Activity picked up during the second half. But the increase was not sufficient to boost the average for the year, and it finished below 1986. The rig count ended the year with 1,162 active rigs, but an annual average of only 936: a new modern low for the annual average of rig activity.

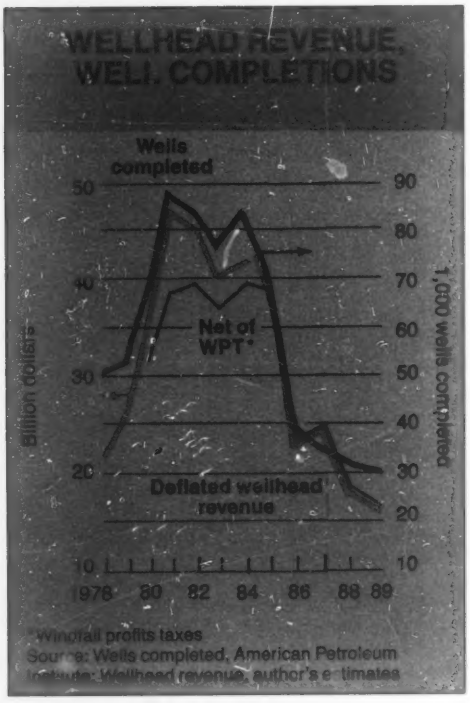
The industry was optimistic that 1988 would show an improvement in rig activity. The year started out well but OPEC production decisions weakened the price. Rig activity remained sluggish throughout the year. The average rig count for the year was the same as 1998, at 936.

Crude prices moved up again in 1989, but the skepticism had returned. Prices had collapsed in 1986 and 1988 and companies remained extremely reluctant to invest in new exploration and drilling activity. The rig count finally managed to move over 1,000 toward the end of the year. But the 1989 average for the year set another modern day low at 869 active rigs.

SEISMIC ACTIVITY. The level of seismic crew activity is one of the better leading indicators of future drilling activity in the U.S. Movements in the level of seismic crew activity tend to lead drilling activity. However, like drilling, seismic activity is also very closely related to the price of crude oil and/or natural gas. Therefore, seismic activity also went through a very volatile period the past few years.

The seismic crew count moved up rapidly during the drilling boom period. The number of active crews started its climb in April 1976 at 238 crews. And it hit a peak of 744 crews in September 1981, three months prior to the peak in drilling activity. This was one of the warning signals of the coming downturn in drilling activity.

After hitting the peak, the number of



active seismic crews fell steadily to 447 in March 1983. This was one month before the rig count hit a temporary bottom at 1,846 average active rigs in April that year.

The number of active seismiccrews moved up to 498 by October 1983, an increase of 11.4%. The rig count moved up 38% from April to November 1983. The seismic crew count fell slightly in early 1984, rose in mid-year and then fell at year end. The seismic crew count fell sharply during the first half of 1985,
leading the downturn in rig activity. It moved up marginally in the middle of 1985, but then started down again in August 1985, again leading the decline in drilling activity.

The seismic crew count fell sharply in 1986, and this continued into 1987. It hit a low of 150 in March 1987. This was down 79.8% from the peak in September 1981. The count moved up through the remainder of the year and reached 199 in December of 1987. It slipped a bit during the first half of 1988 and then fell abruptly when prices dropped late in the year. The seismic crew count in December 1988 was down to 141, the lowest level in years. This was not a good sign for drilling activity in 1989. The seismic crew count continued to slide in 1989 and fell as low as 124 in June. It moved up slightly over the last half of the year but finished the year at only 132 in December. The average for the year was 131.6. The seismic crew count has remained at this depressed level in 1990, averaging 125 for the first half of the year.

WELL COMPLETIONS. The increase in drilling activity over the 1971–81 period resulted in a substantial surge in U.S. well completions. Total well completions increased from 26,268 in 1971 to 89,234 in 1981, an increase of 239.7%. This was a record high number of U.S. well completions and far surpassed any previous year. There were 69,486 wells completed in 1980, the previous high. Prior to those two years the previous record had been 57,182 wells back in 1956.

Moving along with the number of well completions, the total footage drilled moved up from 127.3 million feet in 1971 to 406.5 million feet in 1981, an increase of 219.5%.

Prices slipped, drilling activity dropped and then well completions fell slowly over the next few years. They fell to 83,889 in 1982, 75,738 in 1983, rebounded to 85,359 in 1984 and were still at a high 70,806 in 1985.

Over the period 1981–85, 405,026 wells were completed, averaging 81,005 per year. This was by far the biggest boom period in the history of the U.S. oil and gas industry drilling. This gigantic number of well completions was one of the major reasons why U.S. crude oil production was able to reverse its long-run decline and actually increase between 1981 and 1985. It is also the reason why U.S. reserves of oil and natural gas were sustained over this period.

During the expansion period, 1971 to

TOTAL WELLHEAD REALIZATIONS AND REINVESTMENT

	Total wellhead revenues ($1,000)	Net of WPT* ($1,000)	(JAS) Total drilling expenditure ($1,000)	Investment ratio (%)
1967	12,274,468		2,299,178	18.7
1968	12,963,514		2,409,360	18.6
1969	13,882,295		2,610,671	18.8
1970	14,919,586		2,578,682	17.3
1971	15,778,480		2,371,492	15.0
1972	15,886,972		2,814,166	17.7
1973	17,951,977		3,074,532	17.1
1974	28,153,951		4,366,989	15.5
1975	32,061,121		6,571,214	20.5
1976	35,801,316		7,461,680	20.8
1977	41,615,676		9,956,453	23.9
1978	46,562,738		13,061,090	28.1
1979	63,164,966		16,078,930	25.5
1980	97,765,720	87,840,720	22,800,356	26.0
1981	138,947,637	113,003,637	36,665,457	32.4
1982	135,526,277	118,772,277	39,428,119	33.2
1983	124,592,334	113,924,334	25,104,543	22.0
1984	132,048,177	123,174,177	25,206,219	20.5
1985	122,047,638	118,047,638	23,696,603	20.1
1986	72,242,658	72,242,658	13,552,403	18.8
1987	75,848,725	75,848,725	9,238,749	12.2
1988	74,814,558	74,814,558	10,549,522	14.1
1989E	74,746,000	74,746,000	11,029,000	14.8

E-Estimate. *Windfall profit tax.

Source: 1970-1988 API, 1989 Author's estimate

DRILLING COSTS*

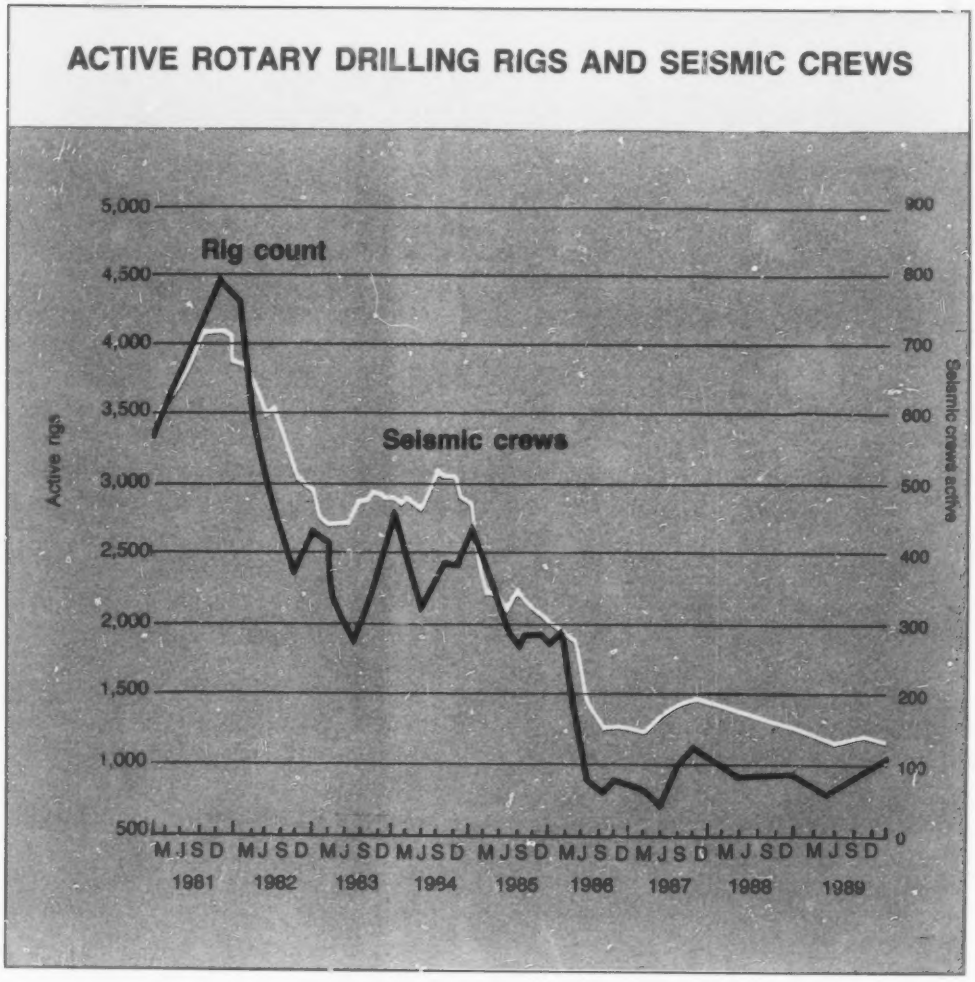
	Total wells†	Total footage† (1,000 ft)	Total expenditures ($1,000)	Avg. cost per well ($)	Avg. cost per foot ($)
1975	36,960	177,642	6,571,214	177,793	36.99
1976	38,941	184,418	7,461,680	191,615	40.46
1977	43,826	212,694	9,956,453	227,181	46.81
1978	46,655	230,619	13,061,090	279,950	56.64
1979	48,523	237,512	16,078,930	331,367	67.71
1980	62,011	296,031	22,800,356	367,682	77.03
1981	80,816	388,800	36,665,456	453,691	94.30
1982	76,652	362,618	39,428,119	514,378	108.73
1983	67,536	301,226	25,104,543	371,721	83.35
1984	77,210	350,589	25,206,219	326,463	71.90
1985	67,821	314,490	23,696,603	349,399	75.35
1986	37,173	176,290	13,552,403	364,577	76.88
1987	33,041	157,357	9,238,749	279,615	58.71
1988	29,741	150,216	10,549,522	354,713	70.23

*From the Joint Association Survey. †Doesn't agree with other reported figures because based on survey.

1981, well completions moved up 239.7%, but rig activity increased 306.7%. The reason for this difference in growth rates was a decline in rig efficiency. The drop in efficiency was due to the employment of less-experienced, less-efficient crews on the new rigs. Well completions per active rotary rig fell from 26.9 wells in 1971 to 22.5 wells in 1981.

On the downswing the opposite was true. From the peak in 1981, well completions fell less than the active rotary rig count. Well completions and the footage drilled held up quite well when compared to the sharp drop in rotary rig activity.

There were 83,889 well completions in 1982, down 6% from 1981. The active rig count fell 21.8% in 1982. By 1985, the rig count had fallen 51%, to 1,980, but well completions were down only 20.7% from the peak. Footage drilled also has not fallen as fast as the rig count. It has remained more closely aligned to the number of well completions. The total footage drilled peaked at 406.5 million feet in 1981. This had fallen to



316 million feet in 1985, down 22.1%.

One of the reasons for the smaller decline in well completions and footage drilled is an improvement in rig efficiency. This was the reverse of what was happening during the upswing. The number of wells completed per active rig moved up to 35.7 in 1985. At that time rigs were working with more experienced crews. And also adding to rig efficiency was a switch to more development drilling. This is less time-consuming than exploration drilling.

During 1986 all of the indicators except rig efficiency collapsed. The active rig count fell another 51.3%, to 964 rigs. And the number of well completions fell 44.8%, to 39,118 wells. In that year the rig count was down 75.7% from the peak and well completions were down 56.2%. But the number of wells completed per active rotary rig climbed to 40.6.

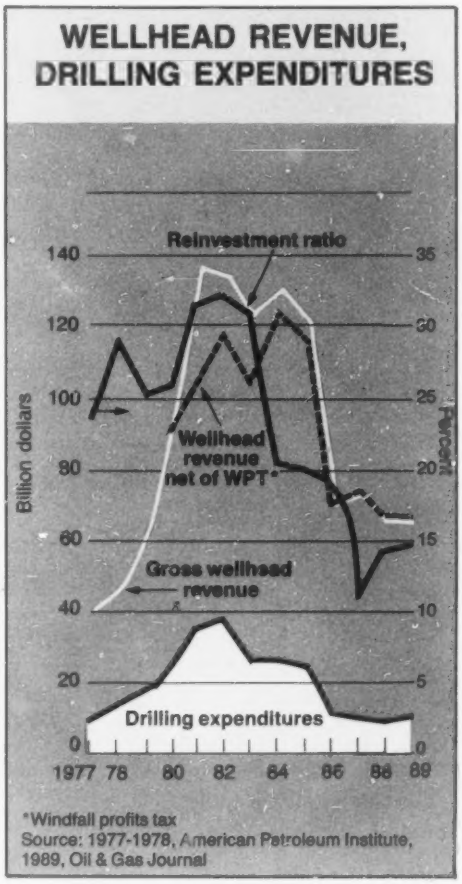
In 1987, the rig count fell to 936 average rigs, down 2.9%. Well completions totaled 35,732, down 8.7%. And the average wells completed per

rig fell to 38.2. This was the first slip in estimated aggregate rig efficiency since 1981.

The number of active rigs remained at an average of 936 in 1988. But the number of new well completions fell to 34,015. Therefore, the number of wells completed per active rig fell to 36.3. In 1989, the rig count dipped to an average 869 and well completions fell to 30,401. Wells per active rig fell to 34.98.

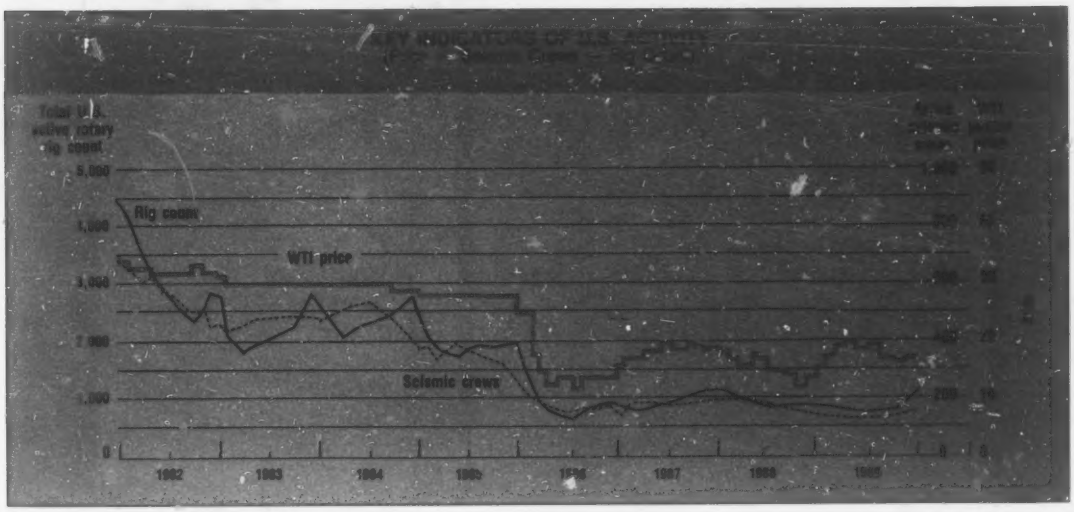
Although rig efficiency has improved, the actual improvement in productivity is marginal when measured annually. One of the major reasons for the disparity between rig count and well completions may be the lack of statistical data covering activity of all types of rigs. The Baker Hughes weekly survey of rig activity records active rotary rigs with a drilling depth capability greater than 2,500 feet. Many, if not most, of the more shallow wells are drilled with other types of rigs, which are not counted in this weekly survey. Since shallow wells are far less costly, the drop in oil prices had not had as big an impact on shallow drilling. Therefore, a larger percentage of the more shallow drilling activity continued during the downturn in the drilling industry. The ratio of total wells drilled to rotary rig activity also includes the wells drilled with other types of rigs. This inflates the number of wells drilled per active rotary rig.

The average number of wells completed that are greater than 2,500 feet may be a better indicator of efficiency. Rotary rigs tend to be used for deeper drilling and, therefore an improvement in the number of these deeper wells drilled per rig is a more accurate efficiency indicator. Wells completed deeper than 2,500 feet per active drilling rig moved up from an average 16.7 during 1971–81 to 18.2 in 1982. This indicator then increased to 21.7 in 1983, 23.4 in 1984, 24.1 in 1985 and 27.1 in 1986. It dropped to 26.2 in 1987, 24.2 in 1988 and 23.4 wells per active rig in 1989. There are a number of factors that influence rig efficiency. But it appears obvious from this rough indicator that rigs are presently employed more efficiently than in the expansion and boom years.



Also of note is the fact that the average depth of wells fell rather sharply from 4,556 feet per well in 1981 to 4,180 feet per well in 1983. Part of the reason for the drop in average depth was a shift away from deep gas well drilling and a concentration on shallow oil well drilling.

The drop in demand for natural gas and the slowdown of the climb in natural gas prices led to the curtailment of a substantial amount of natural gas drilling. Between 1979 and 1983, demand for natural gas fell 17%. This led to the natural gas surplus and resulted in a decline in gas well drilling. This was particularly true for deep gas wells, below 10,000 feet. Close to 1,500 of the rigs



that were idled were attributed to the decline in deep well drilling.

The average depth per well has moved up in the last couple of years, reaching 4,537 feet per well in 1987 and 4,670 feet per well in 1988. This rise was due to a sharp drop in shallow well drilling, much of which had relatively poor reserve prospects, and an increase in gas well drilling. The average depth per well slipped marginally to 4,523 feet in 1989.

WELLHEAD PRICES AND REVENUES. To get a better perspective on what determines the level of exploration and drilling activity, it is essential to take a look at wellhead prices and wellhead revenues.

The close relationship between wellhead prices and rig activity has been documented several times. Between 1971 and 1973, the average wellhead price of oil moved up 123%, and the rig count increased 70.1%. From 1975 to 1981, the average wellhead price increased 320.2%, and the rig count moved up 139.2%.

During this expansion phase of the drilling cycle, the average wellhead price of natural gas was also moving up rapidly. The price increased from 22 ct. per thousand cubic feet (mcf) in 1973 to $2.66/mcf in 1984. Between 1973 and 1982, the price increased 1,018%. This is an average annual increase of 31%. The natural gas price moved up an additional 5.3% in 1983, and 2.7% in 1984. These later price increases weren't sufficient to stop the slide in drilling activity. But they did provide some additional wellhead revenue to help support additional drilling.

The downturn in drilling activity started after 1981 and followed the fall in prices. Between 1981 and 1985, the average wellhead price of crude oil fell 24.2% and the active rotary rig count fell 50%. And in 1986, the average wellhead price collapsed, falling 48.1%, and the active rig count fell 51.3%.

Exerting additional downward pressure on rig activity during this period, the wellhead price of natural gas fell. This dragged the rig count down even more. The wellhead price of natural gas fell 6.6% in 1985 to $2.51/mcf. And then in 1986 it fell another 22.7%, to $1.94/mcf. It continued down in 1987, falling to $1.67/mcf. The price in 1987 was down 37.2% from the peak in 1984.

The prices of crude oil and natural gas, coupled with the volume of production, determine

INDEX OF COST OF DRILLING AND EQUIPPING WELLS

(1984 = 100)	Weight (%)	1984	1985	1986	1987	1988	1989*
Payments to drilling contractors	29.8	100.0	101.0	85.9	64.4	77.3	73.5
Purchased items							
Road site preparation	6.3	100.0	101.7	103.6	106.2	108.5	110.1
Transportation	2.9	100.0	100.0	100.0	100.0	100.0	100.0
Fuel	1.2	100.0	95.3	58.4	65.4	59.1	68.8
Drilling mud and additives	5.8	100.0	100.6	100.6	100.6	100.6	100.6
Well site logging and/or monitoring system	1.6	100.0	100.0	100.0	87.4	88.9	104.6
All other physical tests	0.5	100.0	100.0	100.0	133.2	138.8	164.1
Logs and wireline evaluation services	4.1	100.0	89.9	67.4	73.0	79.5	75.7
Directional drilling services	0.8	100.0	98.8	98.8	98.8	104.0	115.4
Perforate	2.0	100.0	100.0	100.0	100.0	151.7	182.3
Formation treating	4.2	100.0	94.0	89.3	94.0	95.4	101.2
Cement and cementing services	4.3	100.0	92.7	86.5	90.8	97.3	102.3
Casing and tubing	16.8	100.0	98.8	92.0	98.8	120.0	129.9
Casing hardware	0.7	100.0	98.8	92.0	98.8	120.0	129.9
Special tool rentals	3.1	100.0	100.0	100.9	102.0	102.0	102.0
Drill bits and reamers	1.6	100.0	100.4	98.8	101.2	116.5	118.8
Wellhead equipment	2.0	100.0	103.8	103.9	101.8	105.5	106.6
Other equipment and supplies	2.5	100.0	100.3	99.1	99.8	103.6	106.0
Plugging	0.7	100.0	98.1	97.4	100.4	99.5	103.5
Supervision and overhead	3.0	100.0	103.3	108.1	106.5	109.3	115.2
All other expenditures	6.1	100.0	100.4	96.8	99.3	102.9	105.3
Sub-total purchased items	**70.2**	**100.0**	**98.7**	**94.4**	**97.5**	**106.4**	**111.8**
Total†	**100.0**	**100.0**	**99.4**	**91.9**	**87.6**	**97.7**	**100.4**

*Preliminary. †Weighted according to 1982 weights for all years.
Source: IPAA

the level of wellhead realizations or revenues flowing from production activities. This is also the pool of investment funds that supports a great deal of the future drilling activity. It is expected that a portion of this revenue will be reinvested in exploration and drilling. The total revenue from crude oil and natural gas production and the rate at which it is reinvested are key determinants of the level of drilling activity.

With rising oil and gas prices in the 1970s, total wellhead revenues moved up rapidly. Total U.S. wellhead realizations were $15,778 million in 1971. This moved up and peaked in 1981 at $138,947 million. This was also the year of peak oil prices and a year with a relatively high level of demand for natural gas. At that time the windfall profit tax (WPT) took a portion of the total revenues available. In 1981, net of this excise tax, total wellhead revenues were $113,004 million. Producers were generating 616.2% more revenue per year than they had been 10 years earlier. An additional $97.2 billion was flowing to oil and gas producers, investors, royalty owners, and into state and federal excise taxes.

In addition to the high level of revenue available, the reinvestment ratio in 1981, at 32.4%, was the highest since 1970. The reinvestment ratio is the percentage of total wellhead revenues that are invested in drilling. Total drilling expenditures in 1981 were $36,665 million.

Total wellhead revenues available to the industry and the reinvestment ratio moved up even higher in 1982. Crude oil prices had started to slide in 1982, but they were still high. In addition, crude oil production moved up, and natural gas prices were up. Total gross wellhead revenues slipped to $135,526 million, but revenues net of the windfall profit tax moved up to $118,772 million. And the reinvestment ratio moved up to 33.2%. Total drilling expenditures moved up to a peak of $39,428 million.

As oil prices declined and natural gas demand fell, total wellhead realizations net of the WPT fell to $113,924 million in 1983. Some outside funds stopped flowing into the industry. And the high debt that the industry had accumulated

WELL COST AND OIL PRODUCTION

Year	Average cost per well ($)	Wellhead price of oil ($/bbl)	Barrels of oil to cover well cost
1970	94,885	3.18	29,838
1971	94,708	3.39	29,937
1972	106,424	3.39	31,394
1973	117,152	3.89	30,116
1974	138,718	6.74	20,581
1975	177,793	7.56	23,518
1976	191,615	8.19	23,396
1977	227,181	8.57	26,509
1978	279,950	9.00	31,106
1979	331,367	12.64	26,216
1980	367,682	21.59	17,030
1981	453,691	31.77	14,280
1982	514,378	28.52	18,036
1983	371,721	26.19	14,193
1984	326,463	25.88	12,614
1985	349,399	24.09	14,504
1986	364,577	12.51	29,143
1987	279,615	15.40	18,157
1988	354,713	12.58	28,197
1989E	362,788	15.85	22,889

E-Estimate

Source: Department of Energy and API 1970-1988; Author's estimates 1989

during the peak years had to be financed. This reduced the reinvestment ratio sharply to 22% in 1983. Drilling expenditures fell to $25,105 million.

Total wellhead revenues moved up in 1984 to $123,174 million, net of WPT. Increased natural gas demand was the major reason for the increase. This was partially offset by lower crude oil prices. However, the reinvestment ratio fell to 20.5%. Total drilling outlays were an estimated $25,206 million in 1984. It should be noted that a portion of the drop in drilling expenditures in 1983 and 1984 was due to lower drilling costs. Therefore, the drilling activity level did not drop as much as outlays.

In 1985 the wellhead revenues available to the industry fell to $118,048 million and the reinvestment ratio slid again to 20.1%. Drilling outlays dropped down to $23,697 million.

The sharp drop in wellhead revenues and drilling expenditures came with the collapse of prices in 1986. Wellhead revenues fell to $72,243 million, just above the level in 1979. And the reinvestment ratio plummeted to 18.8%. Drilling expenditures fell to the lowest level since 1978, at an estimated $13,552 million.

Wellhead revenues increased in 1987 due to a partial rebound in crude prices. Revenues moved up to $75,849 million. But a pessimistic outlook still prevailed with respect to drilling. The reinvestment ratio fell to 12.2% and drilling outlays dipped to $9,239 million. The reinvestment ratio was one of the lowest on record and drilling expenditures were the lowest since 1977.

Wellhead revenues continued the fall in 1988 due to the drop in crude oil prices. They dipped to $67,574 million, about on par with the $63,165 million in 1979. The reinvestment ratio moved up to 15.6% and drilling expenditures to $10,550 million. Wellhead revenues for 1989 increased to an estimated $73,576 million. The reinvestment ratio dropped once more to about 12.2% and drilling spending fell again.

DRILLING COSTS. Increased drilling activity boosted expenditures substantially during the boom years. However, a large part of what was being spent on drilling activity during the boom years was a result of inflation in the cost of drilling a well. According to the Joint Association Survey of Drilling Costs, the average cost of drilling a well increased from $117,152 in 1973 to $514,378 in 1982. This was the record high for the average well cost.

The cost of drilling has fallen sharply since the peak of the drilling boom in 1981–82. In 1983, the average cost per well fell sharply to $371,721, a drop of 27.7%. The cost continued to slide in 1984, with the average well cost falling to $326,463, down 36.5% from the peak.

The sharp drop in well costs was primarily due to competition in the drilling service and supply industry, brought on by the excess capacity and excess inventory that accompanied the drilling decline. Drilling contractors, as well as equipment and service companies, came away from the boom period with huge excess inventories and production capacities. Prices were slashed in an effort to reduce inventories and use idle capacity.

TOTAL U.S. OPERATING OIL WELLS

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Flowing	34,786	34,529	38,060	36,065	32,994	36,104	37,665	35,148	32,870	32,497
Artificial lift	492,069	508,981	518,949	544,077	570,296	584,093	609,070	588,256	587,311	579,951
Total	526,855	543,510	557,009	580,142	603,290	620,197	646,735	623,404	620,181	612,448

Source: American Petroleum Institute

TOTAL U.S. SUPPLY OF TUBULAR GOODS

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Tubular goods (Thous. tons)											
Mill shipments	2,647	2,458	3,612	4,241	1,759	677	1,406	1,299	483	919	1,130
Less exports	−155	−285	−133	−128	−67	−8	−12	−14	−36	−30	−74
Plus imports	591	457	1,036	2,389	2,180	565	2,214	1,506	617	570	988
U.S. supply	3,083	2,630	4,515	6,502	3,872	1,234	3,608	2,791	1,064	1,459	2,044
Footage drilled (Thous. ft.)	238,386	243,685	311,445	406,520	375,706	317,996	369,075	316,169	176,370	162,539	153,695
Tons tubular goods Per thous. ft.	12.9	10.8	14.5	16.0	10.3	3.9	9.8	8.8	6.0	9.0	13.3

Source: IPAA

The average cost of a well moved up slightly to $349,399 in 1985 and $364,577 in 1986. But these increases did not reflect a true increase in drilling costs. A greater proportion of high-cost offshore wells were drilled and this increased the average cost estimates.

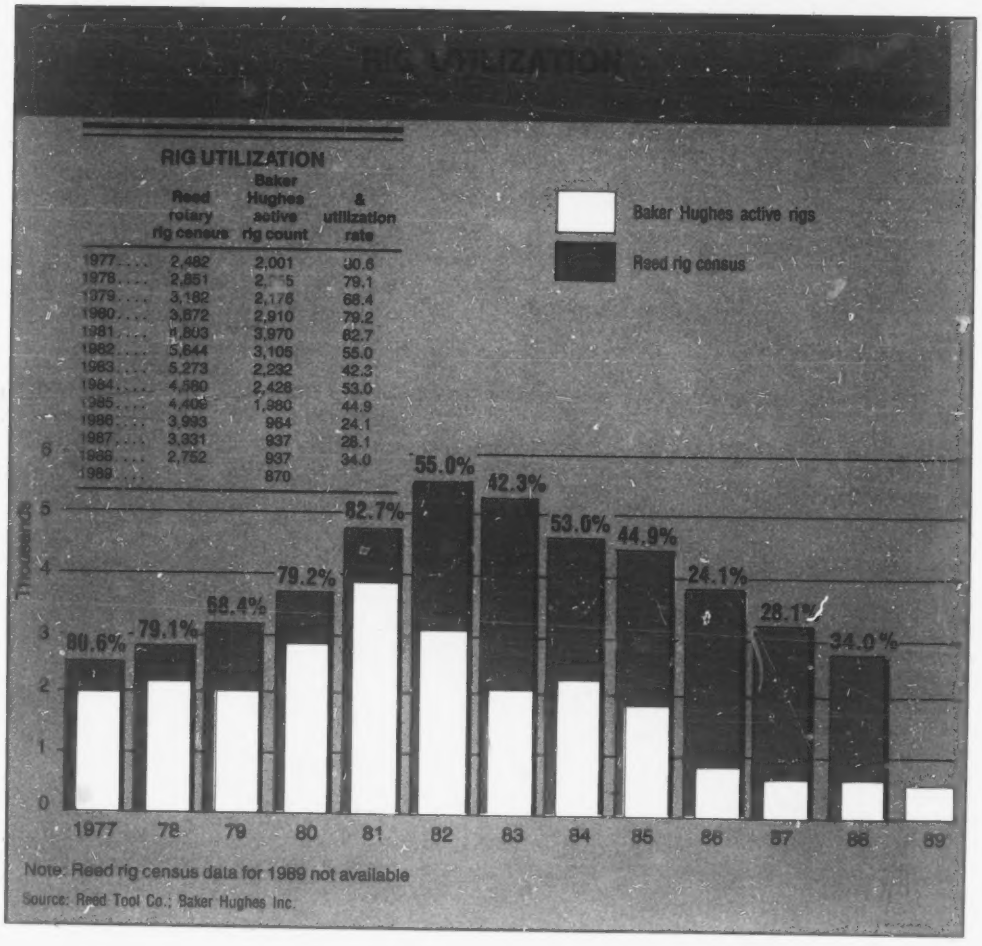
The average well cost fell to $279,615 in 1987. This sharp drop was due to a 21% decrease in offshore wells drilled. The cost per well moved back up in 1988 to $354,713/well.

As stated, one of the reasons for the sharp drop in drilling costs was the intense competition in the industry due to the excess capacity. An indicator of excess capacity is the rig utilization rate. The size of the rig fleet moved up with oil prices, increasing from 1,767 rigs in 1973 to 5,644 rigs in 1982. Based on the annual average number of rotary rigs running, the rig utilization rate moved up from 52.5% in 1971 to 81.9% in 1975. The rate stayed in the 68% to 80% range from 1976 to 1980 as the fleet size grew along with the number of active rigs.

The utilization rate hit 82.7% in 1981 as rig activity moved up faster than rig construction. The rig fleet was still growing in 1982 as rig activity fell, and the utilization rate plummeted to 55%. The rig fleet was reduced to 5,273 in 1983, but activity fell faster, and the utilization rate dropped to 42.3%. The total rig fleet was cut again to 4,580 in 1984, and the utilization rate moved up to 53%. In 1985, the rig fleet still stood at 4,409, but the number of active rigs fell to 1,980, resulting in a utilization rate of 44.9%.

But the worst wasn't over and competition really intensified in 1986. The rig fleet fell to 3,993 but the rig count plummeted to only 964. This resulted in a utilization rate of only 24.1%. In 1987, the fleet fell to 3,331 available rigs. The active rig count was 936 and the utilization rate moved up slightly to 28.1%. The rig fleet was further reduced to 2,752 in 1988. With 936 active rigs the utilization rate moved up to 34%. It is these extremely low utilization rates that put downward pressure on drilling costs.

One of the ironies of this depression period in the domestic oil industry is that with declining drilling costs offsetting the drop in oil prices, the economics of drilling activity improved slightly between 1982 and 1985. The cost of drilling and equipping a well in 1985 was down 32.1%



RIG UTILIZATION

	Reed rotary rig census	Baker Hughes active rig count	& utilization rate
1977	2,482	2,001	80.6
1978	2,851	2,255	79.1
1979	3,182	2,176	68.4
1980	3,672	2,910	79.2
1981	4,803	3,970	82.7
1982	5,644	3,105	55.0
1983	5,273	2,232	42.3
1984	4,580	2,428	53.0
1985	4,405	1,980	44.9
1986	3,993	964	24.1
1987	3,331	937	28.1
1988	2,752	937	34.0
1989		870	

from the peak. In comparison, the average wellhead price of crude in 1985 was $24.09/bbl, down 24.2% from the peak. The profit margin had improved, relative to the profit margin at the height of the drilling boom.

However, that improvement was lost in 1986 when the wellhead price fell to $12.51/bbl. The 1986 price was down 60.6% from the peak, while estimated well costs were down only 30% from the peak. There was a slight improvement in 1987 when the average price moved up to $15.41/bbl. But this was lost again in 1988 when prices fell back to an average $12.57/bbl.

Another way of illustrating the economics is by comparing the volume of oil required to cover the average cost of a well. Between 1970 and 1979, the number of barrels of oil that needed to be produced, to cover the average cost of a well, ranged from a low of 20,581 to a high of 31,394. This fell to 14,193 barrels in 1983, and only 12,614 barrels in 1984. When well costs moved up in 1985, this went up to 14,504 barrels. When prices collapsed in 1986, the volume of oil required to cover well costs jumped to 29,143 bar-

ROTARY RIG ACTIVITY BY STATES

	Average rig activity											
	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Alabama	12.5	12.6	10.8	17.3	15.3	15.2	15.5	22.3	10.3	10.6	12.0	11.4
Alaska	15.5	13.5	13.8	23.5	21.6	13.8	14.1	20.0	12.8	8.5	12.1	10.9
Arizona	0.4	0.0	1.0	1.1	1.0	0.3	0.2	0.2	0.0	0.2	0.0	0.0
Arkansas	13.9	10.4	26.8	33.9	27.0	25.9	26.1	24.0	9.6	9.1	8.4	8.7
California	94.1	95.6	120.2	154.8	128.8	105.7	107.2	80.0	49.1	60.9	60.0	48.5
Land	86.3	85.7	104.7	133.7	106.2	83.4	89.2	68.3	43.8	54.6	52.9	42.8
Offshore	7.8	9.9	15.5	21.1	22.6	22.3	18.0	11.7	5.3	6.3	7.1	5.7
Colorado	41.1	40.2	61.1	81.6	60.3	52.2	53.9	49.8	24.3	24.8	28.7	26.9
Florida	6.3	5.3	4.1	7.8	4.6	4.4	3.6	6.7	2.2	2.8	1.4	1.8
Idaho	3.2	1.8	2.6	3.2	1.5	1.2	0.8	1.3	1.0	0.4	1.0	0.0
Illinois	28.4	13.1	25.4	42.9	75.5	60.2	41.5	28.4	5.6	3.4	3.9	4.8
Indiana	4.4	0.3	0.1	1.2	7.1	5.9	6.6	3.6	1.2	0.5	0.0	0.1
Kansas	75.5	66.0	120.2	196.2	157.4	124.1	127.6	91.4	46.8	48.5	40.0	42.6
Kentucky	3.3	0.4	1.7	5.3	9.5	8.4	8.1	6.3	2.5	2.0	5.1	5.3
Louisiana	338.3	347.0	427.4	455.6	343.1	283.6	309.9	282.2	142.1	134.7	163.2	139.6
North	39.8	34.5	54.9	58.0	39.9	29.4	30.3	24.5	11.3	11.4	13.9	16.1
Inland waters	62.5	62.1	76.6	83.2	59.2	47.1	51.4	85.4	20.2	22.9	25.0	17.1
South	113.9	112.3	156.4	160.3	107.8	81.9	96.1	43.4	41.8	35.4	36.7	34.7
Offshore	122.1	138.1	139.4	154.1	136.2	125.2	132.3	129.0	68.8	64.9	87.6	71.7
Maryland	0.7	0.5	0.2	0.6	0.0	0.0	0.0	0.6	0.2	0.0	0.0	0.0
Michigan	24.0	25.1	30.7	36.5	31.4	29.1	34.1	33.5	24.0	21.8	19.5	16.8
Mississippi	44.5	40.2	57.6	71.5	41.6	32.8	32.4	30.8	15.3	13.1	17.5	16.7
Montana	30.1	32.9	49.2	81.4	36.2	23.9	36.0	22.7	9.7	8.5	7.8	5.3
Nebraska	9.6	9.2	14.3	15.0	9.4	9.0	9.1	6.4	3.1	5.2	2.9	1.3
Nevada	2.9	4.1	4.6	4.9	3.0	1.1	5.0	4.9	2.9	1.5	1.8	2.4
New Mexico	75.5	87.5	117.6	134.9	103.3	65.0	77.8	71.1	29.0	34.6	36.9	35.9
New York	7.0	8.7	7.0	11.6	15.1	10.2	8.9	4.8	2.2	2.0	1.1	0.5
North Dakota	39.1	56.5	83.4	118.8	69.4	42.5	50.9	38.3	13.3	14.1	14.5	14.6
Ohio	45.6	46.3	73.7	97.8	56.8	39.3	51.1	28.8	17.5	19.6	13.8	12.9
Oklahoma	258.2	246.7	397.3	698.4	621.5	285.5	319.2	251.3	141.2	136.1	125.3	121.8
Pennsylvania	25.2	28.9	29.0	38.6	32.6	22.0	35.5	29.5	17.9	17.4	18.7	17.3
Rhode Island offshore	4.3	4.0	2.1	2.0	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
South Dakota	2.3	1.4	1.9	2.2	1.5	1.0	2.2	1.7	0.6	0.4	0.7	0.8
Texas	855.0	770.2	987.7	1,317.0	989.6	797.5	850.1	676.6	310.9	293.0	280.3	263.4
Gulf Coast	197.0	141.3	210.5	305.2	169.0	133.9	138.1	101.3	44.5	42.4	36.8	38.2
Offsh & inland waters	46.9	50.3	72.1	74.5	88.3	56.2	60.1	51.5	21.7	19.8	25.4	22.8
North	153.2	122.4	147.2	170.7	138.1	125.0	99.6	86.9	36.5	23.8	28.5	23.6
Panhandle	60.4	48.1	50.8	66.6	66.2	48.3	49.9	37.2	16.0	16.8	15.1	11.2
East	116.6	107.0	119.8	163.9	115.7	102.2	102.1	77.2	45.4	36.2	37.6	51.2
West Central	117.2	109.4	140.4	191.6	139.8	102.7	124.5	81.8	41.7	44.8	43.9	42.3
West	163.7	191.7	247.1	344.5	272.5	229.2	276.9	240.7	105.1	109.3	93.0	74.1
Utah	32.1	28.9	42.4	69.2	39.8	36.8	45.3	28.5	11.1	7.4	6.1	5.3
W. Virginia	27.1	29.8	37.8	44.8	49.4	33.9	37.7	26.1	15.0	12.6	12.6	15.9
Wyoming	136.4	147.2	155.5	191.3	142.7	95.6	114.6	92.1	35.4	39.3	36.8	33.5
Others	2.0	2.9	3.3	8.6	6.5	5.0	3.2	4.9	6.9	3.1	4.4	3.6
Total U.S.	**2,258.8**	**2,177.2**	**2,910.3**	**3,969.5**	**3,104.9**	**2,232.3**	**2,428.2**	**1,968.5**	**963.5**	**935.9**	**936.3**	**868.6**
Canada land	270.2	334.6	396.4	258.6	195.0	189.5	242.8	302.1	174.8	179.3	194.4	126.6
Canada offshore	1.5	4.1	4.7	4.8	5.4	10.4	13.5	9.1	4.1	2.0	2.5	1.1
Grand total	**2,530.5**	**2,515.9**	**3,311.4**	**4,232.9**	**3,305.3**	**2,432.2**	**2,684.6**	**2,279.7**	**1,142.5**	**1,117.1**	**1,133.2**	**996.3**

Source: Baker Hughes Inc. Note: Columns may not add due to independent rounding.

RIG EFFICIENCY, WELLS DEEPER THAN 2,500 FT

Year	Rig count	Wells	Footage (Million)	Wells/ rig	Footage/ rig	Ft/well (Avg. depth)
1970	1,028	20,146	127.8	19.6	124,364	6,346
1971	976	18,226	116.4	18.7	119,260	6,386
1972	1,107	19,990	127.6	18.1	115,270	6,383
1973	1,194	20,464	129.1	17.1	108,120	6,309
1974	1,471	22,736	139.3	15.5	94,700	6,127
1975	1,660	27,140	164.4	16.3	99,040	6,057
1976	1,656	28,003	168.7	16.9	101,750	6,024
1977	2,001	32,803	196.8	16.4	98,350	5,999
1978	2,255	36,149	218.5	16.0	96,720	6,044
1979	2,176	36,096	221.1	16.5	101,560	6,125
1980	2,910	46,903	279.7	16.1	96,120	5,963
1981	3,970	62,009	368.8	15.6	92,800	5,948
1982	3,105	56,490	338.6	18.2	109,043	5,994
1983	2,232	48,357	280.7	21.7	125,775	5,805
1984	2,428	56,808	330.6	23.4	136,160	5,820
1985	1,980	47,881	285.9	24.2	144,394	5,971
1986	964	26,393	160.9	27.4	166,909	6,096
1987	937	24,491	146.9	26.2	156,944	5,998
1988	937	23,413	145.0	25.0	154,773	6,194
1989	870	20,309	123.9	23.3	142,391	6,100

rels. With an increase in crude oil prices in 1987, it improved, falling to only 18,157 barrels. But with crude oil prices down again in 1988, it jumped to 23,913 barrels. This volatility makes drilling decisions very difficul

PRODUCING WELLS. With the surge in well completions, the total number of producing wells in the U.S. moved up sharply. It reached an estimated 889,970 by year end 1985. In addition to new well completions, the higher oil and gas prices helped lengthen the life of old wells and slowed abandonments.

But when prices plummeted in 1986, the number of abandonments increased sharply. In 1986, the number of abandoned wells exceeded the number of well completions. The total number of producing wells fell to 870,217.

The number of producing oil wells dropped from 646,626 in 1985 to 628,690 at the end of 1986. The number of producing gas wells fell from 243,344 wells to 241,527.

Oil well abandonments exceeded completions again in 1987. Therefore, the number of producing oil wells fell to 620,181. There was a slight increase in the number of producing gas wells to 249,225. The total number of producing oil and gas wells slipped to 869,406. Abandonments slowed in 1988. Completions exceeded abandonments and the total number of producing wells increased to 879,591. Producing oil wells moved up to 623,587 and gas wells moved up to 256,004.

It appears that abandonments lag behind prices a bit. Oil prices fell sharply again in 1988 and abandonments jumped up in 1989. Oil well abandonments moved up to 31,345, far outnumbering completions of 11,123. Therefore the number of producing oil wells fell to 603,365. The number of producing gas wells continued to move up, increasing to 261,139.

OUTLOOK

The sharp reduction in worldwide crude oil supply pushed up the average price of world export crude oils 50% in the three weeks following the invasion. This has also resulted in higher wellhead prices in the U.S. With higher prices the cash flow from production operations has also increased substantially. Wellhead revenues have been boosted by this increase in oil prices.

The length of time that prices remain elevated will play a major role in determining the level of wellhead revenues and the funds available for investment in exploration and production activities over the forecast period.

At this time it is uncertain how long the crisis involving Iraq and Kuwait will last. It is quite probable that the loss of this volume of crude oil will exert upward pressure on crude oil prices as long as the crisis continues. This makes it almost impossible to project with any certainty the most likely trend in wellhead revenues and E&P investments over the forecast period.

Therefore, in this edition of the Oil Industry Outlook, three scenarios are being presented. The three scenarios vary in expectations of the length of time the crisis in the Persian Gulf will last. The length of time the oil crisis continues will determine the trend in the price of crude oil and therefore the trend in oil industry revenues and exploration and drilling activity. To cover these possible variations three separate forecasts

are presented. The forecast with the highest degree of probability is the one that comes closest to estimating the length of time it takes to finally resolve this issue in the Middle East, and for Iraqi and Kuwaiti oil to return to the market.

Following is a brief review of the key points of each scenario. They are discussed in more detail in earlier chapters.

Scenario I—The embargo of oil exported from Iraq and Kuwait continues for a period of 6–18 months. The vast majority of oil production in Iraq and Kuwait is shut in for the duration of the dispute. Oil production capacity in other OPEC areas is not affected by the dispute. Following the settlement of the dispute, production in Iraq and Kuwait is resumed at previous levels.

Scenario II—The embargo of oil exported from Iraq and Kuwait continues for a period of 18–30 months. The vast majority of oil production in Iraq and Kuwait is shut in for the extended duration of the dispute. Oil production capacity in other OPEC areas is not affected by the dispute. Following the settlement of the dispute, production in Iraq and Kuwait is resumed at previous levels.

Scenario III—The embargo of oil exported from Iraq and Kuwait continues for less than six months. The vast majority of oil production in Iraq and Kuwait is shut in during this period. Production capacity in other OPEC countries is not affected by this dispute. Following settlement of the dispute, production in Iraq and Kuwait is resumed at previous levels.

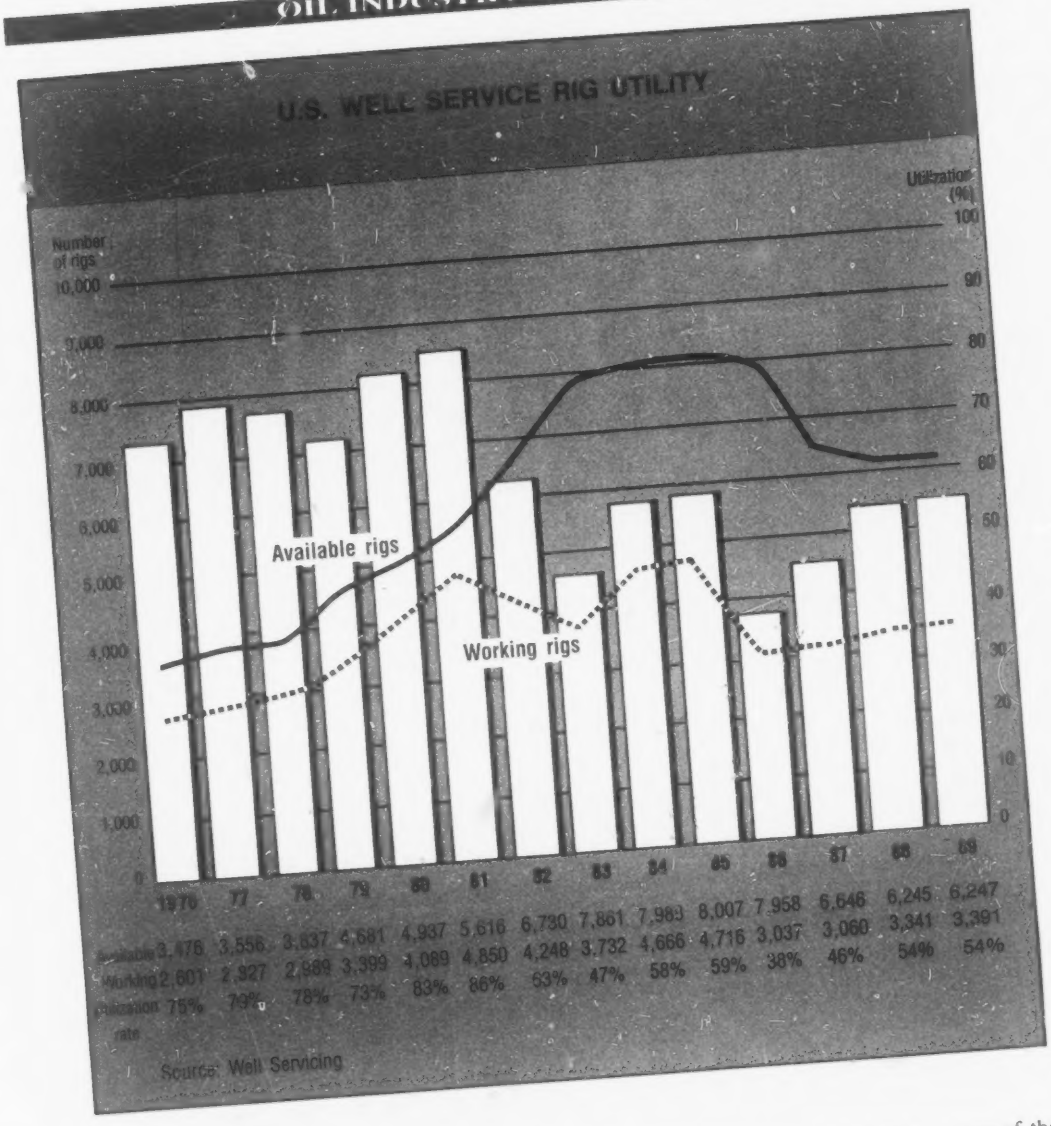
The major differences between the three scenarios is the length of time that the crisis continues and Iraqi and Kuwaiti oil is off the market. But even though the length of time until settlement of the dispute is the only apparent difference, these three scenarios will cause three distinct sets of conditions in the oil market. And the different market conditions will create differing projections of price and level of wellhead revenues, investment and exploration, drilling and production activity over the forecast period, 1991–95.

RECORD HIGH AND LOW
Rotary rigs running — by States

State	Rig count 12-28-81	Rig count 7-14-86	Change 86-81	% change 86/81
Alabama-Land	20	3	– 17	– 85.0
Alabama-Offshore	3	2	– 1	– 33.3
Total Alabama	23	5	– 18	– 78.3
Alaska-Land	27	11	– 16	– 59.3
Alaska-Offshore	0	1	1	—
Total Alaska	27	12	– 15	– 55.6
Arkansas	42	7	– 35	– 83.3
California-Land	151	35	– 116	– 76.8
California-Offshore	25	2	– 23	– 92.0
Total California	176	37	– 139	– 79.0
Colorado	93	10	– 83	– 89.2
Florida-Land	4	1	– 3	– 75.0
Florida-Offshore	1	0	– 1	– 100.0
Total Florida	5	1	– 4	– 80.0
Georgia	0	1	1	—
Hawaii	1	0	– 1	– 100.0
Idaho	3	1	– 2	– 66.7
Illinois	105	5	– 100	– 95.2
Indiana	8	1	– 7	– 87.5
Kansas	214	33	– 181	– 84.6
Kentucky	15	3	– 12	– 80.0
N. Louisiana	54	8	– 46	– 85.2
S. Louisiana-Inl Water	87	13	– 74	– 85.1
S. Louisiana-Land	175	38	– 137	– 78.3
S. Louisiana-Offshore	168	44	– 124	– 73.8
Total Louisiana	484	103	– 381	– 78.7
Michigan	40	16	– 24	– 60.0
Mississippi	79	13	– 66	– 83.5
Montana	73	2	– 71	– 97.3
Nebraska	18	2	– 16	– 88.9
Nevada	2	2	0	—
New Mexico	160	11	– 149	– 93.1
New York	21	2	– 19	– 90.5
N. Dakota	123	10	– 113	– 91.9
Ohio	94	15	– 79	– 84.0
Oklahoma	871	99	– 772	– 88.6
Pennsylvania	38	15	– 23	– 60.5
Rhode Island—Offshore	3	0	– 3	– 100.0
S. Dakota	1	0	– 1	– 100.0
Tennessee	1	0	– 1	– 100.0
Texas-Offshore	78	15	– 63	– 80.8
Texas-Inl Water	0	1	1	—
District 1	38	4	– 34	– 89.5
District 2	122	11	– 111	– 91.0
District 3	220	22	– 198	– 90.0
District 4	133	26	– 107	– 80.5
District 5	32	9	– 23	– 71.9
District 6	144	18	– 126	– 87.5
District 7B	88	14	– 74	– 84.1
District 7C	99	9	– 90	– 90.9
District 8	206	30	– 176	– 85.4
District 8A	97	25	– 72	– 74.2
District 9	103	16	– 87	– 84.5
District 10	91	11	– 80	– 87.9
Total Texas	1,451	211	– 1,240	– 85.5
Utah	60	6	– 54	– 90.0
Virginia	3	6	3	100.0
Washington	3	0	– 3	– 100.0
W. Virginia	65	13	– 52	– 80.0
Wyoming	228	21	– 207	– 90.8
Total United States	**4,530**	**663**	**– 3,867**	**– 85.4**
Canada	262	68	– 194	– 74.0
Canada-Offshore	5	6	1	20.0
Grand Total	**4,797**	**737**	**– 4,060**	**– 84.6**

Source: Baker Hughes Inc.

Over the past several years volatility in crude oil prices introduced a great deal of uncertainty into the upstream sector of the oil and gas industry. The situation in the Middle East is not going to reduce this volatility and uncertainty.



This uncertainty has made it very difficult to predict what will happen to domestic U.S. exploration and drilling over the next couple of years.

The OPEC decisions on production level had been determining the price level in recent years. And it has been difficult to predict what the OPEC countries would do concerning production quotas and output. This may be the case again in the future. But currently the loss of production from Iraq and Kuwait has dried up most of the OPEC excess capacity.

During the last few years, U.S. drilling activity has been at historically low levels. But it looks as if this may be the bottom of the cycle. And the most probable outlook is for increased activity over the forecast period, 1990–95 under all three scenarios.

In the short run, for the first part of the

forecast period, the crude shortage on the world market will keep prices elevated. And this will result in a boost in wellhead revenues and an increase in exploration and drilling activity.

Over the longer run, the decisions of OPEC will again be a key to prices and the level of activity. The main objective of most of the OPEC countries is to maximize revenue. Therefore it is doubtful in the long run that the OPEC countries want prices much below $18--20/bbl. They have been shown on several occasions that revenues will improve with a little production discipline and higher prices.

Therefore, under all three scenarios, U.S. domestic crude and natural gas prices are projected to move up over the forecast period. What will be different is the price and activity path over the five years.

SCENARIO I—The crude prices will remain elevated through 1991, due to the tight worldwide crude market. The average wellhead price of U.S. crude increased 20% in 1990, to an estimated $19.05/bbl, following the jump in prices the latter part of the year. The average price is expected to increase another 25%, to $23.80/bbl for 1991. After the dispute is settled in 1992, prices will fall and the average wellhead price for that year is projected at $18.60/bbl. Crude wellhead prices will move up slowly for the remainder of the forecast period to $21.50/bbl in 1995. The average wellhead price of natural gas will not follow the chaotic path of crude prices. Gas prices will move up steadily to an average of $2.30/mcf in 1995, an increase of 31.4%. Prices are expected to move up in the latter years due to increased energy demand and a tighter worldwide crude market.

A result of the early jump in prices will be a substantial increase in domestic wellhead revenues during 1991. The increase from higher crude prices will be partially offset by declining crude production and sluggish natural gas production. Prices will fall in 1992 and wellhead revenues will follow. However, wellhead revenues are expected to move up over the remainder of the forecast period. Rising crude oil and gas prices and increasing natural gas production will boost revenues. This will be partially offset by the continued decline of domestic crude production.

Total wellhead revenues in 1991 are projected to be up 15.7% from 1990, at $94,804 million. The reinvestment ratio is expected to be up due to the improved outlook for the industry. Drilling expenditures are projected to move up 21.8%, to $15,632 million. As a result, the number of active rigs will move up again to average 1,175 for the year, an increase of 16.3%. The number of well completions will also move up, increasing 16% to 39,950 wells. Wellhead revenues are expected to fall in 1992 when prices fall. Even though the reinvestment ratio is expected to improve again, the drop in revenues is expected to result in lower drilling expenditures in 1992. As a result, the number of active rigs will fall to 1,085, and well completions will fall to 37,430.

Over the remainder of the forecast period the rising wellhead revenues and improving reinvestment ratio will boost drilling expenditures. Outlays in 1995 will be $21,208 million, up 65.2% from 1990. Well costs are expected to move up due to deeper drilling and more offshore activity. The number of active rigs will increase to 1,275 in 1995, up 26.2% from 1990. Well completions will increase to 45,900 wells in 1995, up 33.3% over the forecast period. Rig efficiency is expected to improve slightly.

SCENARIO II—The crude prices will remain elevated through 1991 and 1992, due to the tight worldwide crude market. The average wellhead price of U.S. crude increased 20% in 1990, to an estimated $19.05/bbl, following the jump in prices the latter part of the year. The average price is expected to increase another 25%, to $23.80/bbl for 1991. The price will move up another 10%, to an average of $26.20/bbl for 1992. After the dispute is settled in 1993, prices will fall and the average wellhead price for that

year is projected at $18.10/bbl. Crude wellhead prices will move up slowly for the remainder of the forecast period to $20.90/bbl in 1995. The average wellhead price of natural gas will not follow the chaotic path of crude prices. Gas prices will move up steadily to an average of $2.25/mcf in 1995, an increase of 28.6%. Prices are expected to move up in the latter years due to increased energy demand and a tighter worldwide crude market.

A result of the early jump in prices will be a substantial increase in domestic wellhead revenues during 1991 and 1992. The increase from higher crude prices will be partially offset by declining crude production and sluggish natural gas production. Natural gas production is expected to decline in 1992 due to weak economic growth. Prices will fall in 1993 and wellhead revenues will follow, also falling sharply. However, wellhead revenues are expected to move up over the remainder of the forecast period. Rising crude oil and gas prices and increasing natural gas production will boost revenues. This will be partially offset by the continued decline of domestic crude production.

Total wellhead revenues in 1991 are projected to be up 15.7% from 1990, at $94,804 million. Wellhead revenues will move up another 7.2%, to $101,627 million. The reinvestment ratio is expected to be up due to the improved outlook for the industry. Drilling expenditures are projected to move up 21.8%, to $15,632 million. As a result, the number of active rigs will move up again to average 1,175 for the year, an increase of 16.3%. The number of well completions will also move up, increasing 16% to 39,950 wells. Wellhead revenues are expected to increase again in 1992 when prices continue to move up. The reinvestment ratio is expected to improve again, and coupled with the increase in revenues is expected to result in higher drilling expenditures again in 1992. The outlays for drilling will move up another 20.2%, to $18,792 million. As a result the number of active rigs will increase to 1,295, and well completions will increase to 44,675. In 1993, when the dispute is settled, crude prices will fall. Wellhead revenues will follow prices and drop sharply to $80,548 million, down 20.7%. The reinvestment ratio will improve marginally but drilling outlays will still fall sharply to $15,144 million, down 19.4%. As a result, the rig count will dip to 1,055 and well completions will drop to 36,925.

Over the last two years of the forecast period, the rising wellhead revenues and improving reinvestment ratio will boost drilling expenditures. Outlays in 1995 will be $20,280 million, up 58% from 1990. Well costs are expected to move up due to more deep drilling and more offshore activity. The number of active rigs will increase to 1,240 in 1995, up 22.8% from 1990. Well completions will increase to 44,640 wells in 1995, up 29.6% over the forecast period. Rig efficiency is expected to improve slightly.

SCENARIO III—The crude prices will remain elevated only through late 1990 and possibly into early 1991, due to the tight mworldwide crude market. The average wellhead price of U.S. crude increased 17% in 1990, to an estimated $18.55/bbl, following the jump in prices the latter part of the year. Since the dispute will be settled by early 1991, the average price is expected to fall in 1991 to $17.15/bbl, down 7.5%. Crude wellhead prices will move up slowly for the remainder of the forecast period to $22.00/bbl in 1995. The average wellhead price of natural gas will not follow the path of crude prices. Gas prices will move up steadily to an average of $2.40/mcf in 1995, an increase of 37.1%. Prices are expected to move up due to increased energy demand and a tighter worldwide crude market.

A result of the drop in crude prices in 1991 will be a drop in domestic wellhead revenues during 1991. Crude prices will be down, natural gas prices will be up, crude production will fall and natural gas production will rise. These will offset each other and revenues will drop about 2%. Prices will start to rise again in 1992 and wellhead revenues will follow. Prices for crude and natural

gas, and wellhead revenues, are expected to move up over the remainder of the forecast period. Rising crude oil and gas prices, and increasing natural gas production, will boost revenues. This will be partially offset by the continued decline of domestic crude production.

Total wellhead revenues in 1991 are projected to be down 2% from 1990, at $79,052 million. However, the reinvestment ratio is expected to be up due to the improved outlook for the industry. Drilling expenditures are projected to move up 4.4%, to $13,348 million. As a result, the number of active rigs will move up again to average 1,025 for the year, an increase of 2%. The number of well completions will also move up, increasing 1.5% to 34,850 wells. Wellhead revenues are expected to move up over the remainder of the forecast period. The rising wellhead revenues and improving reinvestment ratio will boost drilling expenditures. Outlays for drilling in 1995 will be $21,765 million, up 70.2% from 1990. Well costs are expected to move up due to deeper drilling and more offshore activity. The number of active rigs will increase to 1,305 in 1995, up 29.9% from 1990. Well completions will increase to 46,980 wells in 1995, up 36.9% over the forecast period. Rig efficiency is expected to improve slightly.

There are some general trends in activity that are expected to show up during the forecast period, no matter which scenario path is followed.

Over the forecast period there will be an increase in cash flow into the upstream sector due to improved wellhead revenues. Some renewed optimism concerning the future of the oil exploration business is expected to result in an increase in the reinvestment ratio. In addition, increased profitability, resolution of debt problems, and an increase in outside investment money will boost the reinvestment ratio from 14.8% in 1989 to 21.5–21.9% by 1995.

The combination of higher wellhead revenues and an increased reinvestment ratio will result in higher drilling expenditures, which in turn will result in a higher number of active rotary rigs and more well completions. These latter indicators will not increase as rapidly as total spending because there will be an increase in average well costs and a shift to deep well drilling. The number of deep wells is expected to increase over the forecast period with renewed exploration activity and increased natural gas drilling. There will be a steady search for more economically attractive reservoirs.

The rough measures of drilling rotary rig efficiency are expected to show little change over the forecast period. There will be a shift to deeper wells and more exploratory work. And these wells take longer to complete. These changes are expected to be offset by gains in operational efficiency.

The economics of oil well drilling are not expected to improve over the forecast period due to an increase in crude prices. Well costs are expected to move up faster than prices. But the economics of gas well drilling should improve. In this case, prices are expected to move up faster than well costs.

The number of well abandonments is expected to decline slowly throughout the forecast period. With increased prices, producers will be able to maintain marginal wells for a longer period. The total number of producing wells will steadily increase as well completions outnumber abandonments.

EXPLORATION, DRILLING, PRODUCTION KEYS TO THE FUTURE SCENARIO I

1. The crisis in the Middle East will produce a tight crude supply situation for worldwide crude through 1991. This will keep crude prices elevated throughout 1991. When the dispute is settled in 1992, crude oil prices will fall sharply. U.S. wellhead crude prices will follow world prices. Crude prices will move up over the remainder of the forecast period due to increased energy demand. Natural gas wellhead prices in the United States will also move up over the forecast period.

2. Wellhead revenues will be up sharply in 1991 due to the higher oil prices. Revenues will increase even though U.S. crude oil production will fall. Wellhead revenues will drop in 1992 when crude prices fall. For the remainder of the forecast period, increased crude and natural gas prices will couple with increased natural gas production to boost wellhead revenues. That increase will be partially offset by lower crude production.

3. Increased wellhead revenues and higher prices will boost investor interest and confidence in the oil business. The reinvestment ratio will move up throughout the forecast period, making more money available for drilling.

4. Drilling expenditures will move up sharply in 1991 due to the higher wellhead revenues. Drilling outlays will slip in 1992, when prices and wellhead revenues fall. Over the remainder of the forecast period, drilling spending will be boosted by increased revenues and the higher rate of reinvestment. The improved picture for prices will encourage more exploration and drilling activity.

5. The increase in drilling outlays will boost the rig count, the number of well completions and the total footage drilled. The rig count will increase sharply in 1991 to 1,175 rigs but then fall to 1,085 in 1992 when prices fall. The rig count will move up to 1,275 by 1995.

6. The economics of drilling will depend on the degree of success. Well costs will move up faster than crude prices but not as fast as natural gas prices. Some excess capacity in the service and supply industry and increased efficiency will hold down well cost

THE OUTLOOK—EXPLORATION, DRILLING, PRODUCTION
SCENARIO — I

	1989	1990	1991	1992	1993	1994	1995	Change 1990 to 1995	% change 1990 to 1995
DRILLING ACTIVITY — U.S.									
Active drilling rigs	869	1,010	1,175	1,085	1,145	1,210	1,275	+265	+26.2
Well completions	30,401	34,440	39,950	37,430	40,075	42,955	45,900	+11,460	+33.3
Footage drilled (thousands)	137,492	158,425	183,770	172,925	185,945	200,170	214,810	+56,385	+35.6
Av. well depth	4,523	4,600	4,600	4,620	4,640	4,660	4,680	+80	+ 1.7
Wells drilled per active rig	35.0	34.1	34.0	34.5	35.0	35.5	36.0	+1.9	+ 5.6
Footage drilled per active rig	158,219	156,855	156,400	159,380	162,400	165,430	168,480	+11,625	+ 7.4
REVENUE AND COST									
Av. well cost ($)	362,788	372,666	391,300	401,080	417,120	435,890	462,045	+89,379	+24.0
Total wellhead revenues ($ million)	74,746	81,947	94,804	83,618	87,855	92,106	96,876	+14,929	+18.2
Total drilling expenditures ($ million)	11,029	12,835	15,632	15,012	16,716	18,724	21,208	+8,373	+65.2
% of wellhead revenue invested in drilling	14.8	15.7	16.5	18.0	19.0	20.3	21.9	+6.2	+39.5
PRODUCTION									
Capital expenditures ($ million)	2,408	2,887	3,510	4,340	3,595	4,235	5,075	+2,188	+75.8
Producing wells (oil & gas) (Dec 31st)	864,504	863,282	870,280	870,500	873,710	879,985	889,300	+26,018	+ 3.0
Abandoned wells	35,918	24,524	20,030	25,110	23,900	22,790	21,740	− 2,784	−11.4
PRICES									
Crude Oil (Av. wellhead-$/barrel)	15.85	19.05	23.80	18.60	19.55	20.50	21.50	+2.45	+12.9
Natural Gas (Av. wellhead-$/mcf)	1.71	1.75	1.85	2.00	2.10	2.20	2.30	+0.55	+31.4

EXPLORATION, DRILLING, PRODUCTION KEYS TO THE FUTURE SCENARIO II

1. The crisis in the Middle East will produce a tight crude supply situation for worldwide crude through 1991 and 1992. This will keep crude prices elevated throughout 1991 and 1922. When the dispute is settled in 1993, crude oil prices will fall sharply. U.S. wellhead crude prices will follow world prices. Crude prices will move up over the remainder of the forecast period due to increased energy demand. Natural gas wellhead prices in the U.S. will also move up over the forecast period.

2. Wellhead revenues will be up sharply in 1991 and 1992 due to the higher oil prices. Revenues will increase even though U.S. crude oil production will fall. Wellhead revenues will drop in 1993 when crude prices fall. For the remainder of the forecast period, increased crude and natural gas prices will couple with increased natural gas production to boost wellhead revenues. The increase will be partially offset by lower crude production.

3. Increased wellhead revenues and higher prices will boost investor interest and confidence in the oil business. The reinvestment ratio will move up throughout the forecast period, making more money available for drilling.

4. Drilling expenditures will move up sharply in 1991 and in 1992 due to the higher wellhead revenues. Drilling outlays will slip in 1993 when prices and wellhead revenues fall. Over the remainder of the forecast period, drilling spending will be boosted by increased revenues and the higher rate of reinvestment. The improved picture for prices will encourage more exploration and drilling activity.

5. The increase in drilling outlays will boost the rig count, the number of well completions and the total footage drilled. The rig count will increase sharply in 1991 to 1,175 rigs and then move up again to 1,295 rigs in 1992. The rig count will then fall to 1,055 in 1993 when prices fall. The rig count will move back up to 1,240 by 1995.

6. The economics of drilling will depend on the degree of success. Well costs will move up faster than crude prices but not as fast as natural gas prices. Some excess capacity in the service and supply industry and increased efficiency will hold down well costs.

THE OUTLOOK—EXPLORATION, DRILLING, PRODUCTION
SCENARIO — II

	1989	1990	1991	1992	1993	1994	1995	Change 1990 to 1995	% change 1990 to 1995
DRILLING ACTIVITY — U.S.									
Active drilling rigs	869	1,010	1,175	1,295	1,055	1,140	1,240	+230	+22.8
Well completions	30,401	34,440	39,950	44,675	36,925	40,540	44,640	+10,200	+29.6
Footage drilled (thousands)	137,492	158,425	183,770	205,950	170,960	188,530	208,470	+50,045	+31.6
Av. well depth	4,523	4,600	4,600	4,610	4,630	4,650	4,670	+70	+ 1.5
Wells drilled per active rig	35.0	34.1	34.0	34.5	35.0	35.5	36.0	+1.9	+ 5.6
Footage drilled per active rig	158,219	156,855	156,400	159,035	162,050	165,375	168,120	+11,265	+ 7.2
REVENUE AND COST									
Av. well cost ($)	362,788	372,666	391,300	420,645	410,130	428,585	454,300	+81,634	+21.9
Total wellhead revenues ($ million)	74,746	81,947	94,804	101,627	80,548	86,713	93,185	+11,238	+13.7
Total drilling expenditures ($ million)	11,029	12,835	15,632	18,792	15,144	17,375	20,280	+7,445	+58.0
% of wellhead revenue invested in drilling	14.8	15.7	16.5	18.5	18.8	20.0	21.8	+6.1	+38.9
PRODUCTION									
Capital expenditures ($ million)	2,408	2,872	2,995	3,575	4,065	4,690	5,445	+2,573	+89.6
Producing wells (oil & gas) (Dec 31st)	864,504	863,282	870,680	883,080	882,250	885,720	893,560	+30,278	+ 3.5
Abandoned wells	35,918	24,524	19,630	17,830	25,810	22,960	22,360	− 2,164	− 8.8
PRICES									
Crude Oil (Av. wellhead-$/barrel)	15.85	19.05	23.80	26.20	18.10	19.50	20.90	+1.85	+ 9.7
Natural Gas (Av. wellhead-$/mcf)	1.71	1.75	1.85	2.00	1.95	2.10	2.25	+0.50	+28.6

EXPLORATION, DRILLING, PRODUCTION KEYS TO THE FUTURE

SCENARIO III

1. The crisis in the Middle East will produce a tight crude supply situation for worldwide crude only through late 1990 and possibly into early 1991. This will keep crude prices elevated only for a short period of time. When the dispute is settled by early 1991, crude oil prices will fall sharply. U.S. wellhead crude prices will follow world prices. However, crude prices will move up over the remainder of the forecast period, 1992–95, due to increased energy demand. Natural gas wellhead prices in the U.S. will also move up over the forecast period.

2. Wellhead revenues will fall in 1991 after prices fall. Part of the reason is the decline in U.S. crude oil production. Wellhead revenues will move up in 1992 as crude oil and natural gas prices increase. For the remainder of the forecast period, increased crude and natural gas prices will couple with increased natural gas production to boost wellhead revenues. The increase will be partially offset by lower crude oil production.

3. Increased wellhead revenues and higher prices will boost investor interest and confidence in the oil business. The reinvestment ratio will move up throughout the forecast period, making more money available for drilling.

4. Drilling expenditures will move up in 1991, even though wellhead revenues dip, due to a higher reinvestment ratio. Drilling outlays will move up in 1992 when prices and wellhead revenues increase. Over the remainder of the forecast period, drilling spending will be boosted by increased revenues and the higher rate of reinvestment. The improved picture for prices will encourage more exploration and drilling activity.

5. The increase in drilling outlays will boost the rig count, the number of well completions and the total footage drilled. The rig count will increase marginally in 1991 to 1,025 rigs, and continue up to 1,115 in 1992 when prices and wellhead revenues increase. The rig count will continue to move up to 1,305 by 1995.

6. The economics of drilling will depend on the degree of success. Well costs will move up faster than crude prices but not as fast as natural gas prices. Some excess capacity in the service and supply industry and increased efficiency will hold down well costs.

THE OUTLOOK—EXPLORATION, DRILLING, PRODUCTION
SCENARIO — III

	1989	1990	1991	1992	1993	1994	1995	Change 1990 to 1995	% change 1990 to 1995
DRILLING ACTIVITY — U.S.									
Active drilling rigs	869	1,005	1,025	1,115	1,170	1,240	1,305	+300	+29.9
Well completions	30,401	34,320	34,850	38,470	40,950	44,020	45,980	+12,660	+36.9
Footage drilled (thousands)	137,492	157,870	160,660	178,115	190,415	205,790	220,805	+62,935	+39.9
Av. well depth	4,523	4,600	4,610	4,630	4,650	4,675	4,700	+100	+ 2.2
Wells drilled per active rig	35.0	34.1	34.0	34.5	35.0	35.5	36.0	+1.9	+ 5.6
Footage drilled per active rig	158,219	157,085	156,740	159,740	162,750	165,960	169,200	+12,115	+ 7.7
REVENUE AND COST									
Av. well cost ($)	362,788	372,666	383,000	402,150	418,235	437,055	463,280	+90,614	+24.3
Total wellhead revenues ($ million)	74,746	80,683	79,052	86,279	90,635	96,252	101,235	+20,552	+25.5
Total drilling expenditures ($ million)	11,029	12,790	13,348	15,471	17,127	19,239	21,765	+8,975	+70.2
% of wellhead revenue invested in drilling	14.8	15.9	16.9	17.9	18.9	20.0	21.5	+5.6	+35.2
PRODUCTION									
Capital expenditures ($ million)	2,408	2,872	2,995	3,575	4,065	4,690	5,445	+2,573	+89.6
Producing wells (oil & gas) (Dec 31st)	864,504	862,541	858,880	860,390	864,735	872,270	882,820	+20,279	+ 2.4
Abandoned wells	35,918	25,184	27,240	24,520	23,360	22,250	21,240	− 3,944	−15.7
PRICES									
Crude Oil (Av. wellhead-$/barrel)	15.85	18.55	17.15	19.05	20.00	21.00	22.00	+3.45	+18.6
Natural Gas (Av. wellhead-$/mcf)	1.71	1.75	1.90	2.05	2.15	2.30	2.40	+0.65	+37.1

REFINING AND PETROCHEMICALS

The conflict in the Middle East has resulted in a rapid escalation in the price of crude oil. If the dispute lasts for any length of time, this higher price level will begin to have an impact on demand for petroleum products, demand for energy, and the rate of economic growth.

The price of crude oil therefore will also have an impact on the refining and petrochemical sectors of the oil industry. Higher prices increase the feedstock costs for

these facilities and result in higher product costs. Higher product costs can lead to an adjustment in product demand. This, in turn, has an impact on the refinery and petrochemical plant capacity utilization rate and therefore on product unit costs. To add to this, the higher cost of energy could slow economic growth which would also have an impact on product demand.

Higher product and crude oil prices means that many of the integrated companies will have much higher revenues. The additional revenues will make available additional funds for investment in facility upgrading and expansion.

The length of time that this dispute lasts will have an impact on the downstream sector of the oil industry as well as the exploration and production sector.

The refining and petrochemical industries, both in the United States and worldwide, have gone through a prolonged period of adjustment the last several years. The abrupt movements in crude oil and product prices that plagued exploration and drilling activity also had a substantial impact on the downstream sector of the worldwide oil and gas industry.

The movements in the refining and petrochemical industries did not appear as volatile as in the exploration and production sector. But these downstream sectors have also gone through significant changes. It did not appear as volatile because making significant changes in the level of activity in the refining and petrochemical industries requires a much longer time. Any reductions or additions to capacity tend to be quite costly. Therefore careful analysis is required before making a major change in operations. Adding basic refining distillation capacity requires considerable lead time for planning and construction. Considerable lead time for planning and construction is also required to add facilities for additional processing to handle heavier and more sour crude. To add new petrochemical capacity to meet new demand generated by economic growth requires time for planning and construction. All of these projects are major investments and therefore require careful detailed economic analysis.

And the decision to make any of these changes requires a certain degree of certainty concerning future market prospects. Planning for potential future activity is much more difficult in today's rapidly changing markets than it was in the past. When demand was steadily on the rise through the 1950s, 1960s and 1970s planning consisted of carefully timing new added capacity to meet expected needs.

During that period there was a great deal of certainty about the future trend in demand and the potential capacity required. The level of risk was related to the timing of the investment.

This all changed in the late 1970s when demand peaked and turned down. Although the changes that followed in the refining business did not appear as volatile as in the exploration and production sector, they were probably just as significant, if not more significant. The refining industry had not been through a similar cycle before—a cycle where overall capacity had to be reduced due to a new perception of demand. What was significantly different was the fact that, for the first time, long range expectations were for lower demand.

And now to confuse the issue, expectations have changed again. Product demand again appears to be on the rise. A great deal of uncertainty and risk have been introduced into planning for the refining and petrochemical industries. And it is expected that the markets will be more volatile for the foreseeable future.

REVIEW

REFINING CAPACITY. Virtually from its inception, the refining industry in the United States has been one of slow, consistent growth. The growth had been steady with few interruptions. The exceptions were only some minor slowdowns due to economic recessions.

U.S. REFINERY CAPACITY AND UTILIZATION

	Number of plants*			Total capacity†	Crude runs	Utilization rate	Excess capacity
	Operating	Shut-down	Total	(1,000 b d)		(%)	(1,000 b d)
1973	253	28	281	13,671.4	12,431	90.9	1,240.4
1974	257	27	284	14,361.5	12,133	84.5	2,228.5
1975	262	28	290	14,960.7	12,442	83.2	2,518.7
1976	265	22	287	15,236.6	13,416	88.1	1,820.6
1977	273	18	291	16,398.4	14,605	89.1	1,793.4
1978	290	12	302	17,047.7	14,739	86.5	2,308.7
1979	301	10	311	17,440.9	14,646	84.0	2,794.9
1980	311	8	319	17,988.1	13,482	74.9	4,506.1
1981	315	9	324	18,620.5	12,471	67.0	6,149.5
1982	254	47	301	17,889.7	11,774	65.8	6,115.7
1983	233	25	258	16,859.3	11,685	69.3	5,174.3
1984	214	33	247	16,137.1	12,044	74.6	4,093.1
1985	199	24	223	15,658.8	12,002	76.6	3,656.8
1986	192	24	216	15,458.9	12,716	82.3	2,742.9
1987	195	24	219	15,565.5	12,854	82.6	2,711.5
1988	195	18	213	15,915.4	13,246	83.2	2,669.4
1989	193	11	204	15,654.9	13,401	85.6	2,253.9

*As of January 1. †As of January 1. Includes operating and operable shutdown.

Source: Energy Information Administration

REFINERY CASH OPERATING MARGINS

Year	Gulf Coast average (dollars per barrel) Margins
1975	−0.47
1976	0.26
1977	0.60
1978	0.53
1979	1.47
1980	1.55
1981	0.33
1982	0.27
1983	−0.46
1984	−1.10
1985	−0.02
1986	−0.01
1987	−0.41
1988	1.42
1989	0.97

Source: Wright Killen & Co.

This changed dramatically at the end of the 1970s.

A look at just the last portion of that growth period illustrates vividly what was happening in the industry at the time of the transition.

Demand for petroleum products in the U.S. increased 8.9%, from 17.308 million b/d in 1973 to 18.847 million b/d in 1978. United States refining capacity moved up from 13.7 million b/d in 1973 to 18.6 million b/d in 1981, an increase of 4.9 million b/d or 36.2%. During that period, capacity was expanding to meet increasing actual demand and to meet the certain expected future demand. The number of plants operating increased from 253 in 1973 to 315 in 1981. Total plants moved up from 281 to 324. The number of available plants that were shut down was reduced from 28 in 1973 to just 9 in 1981.

The expansion phase in the refining sector actually continued beyond the peak period for demand. Refining capacity continued to increase through 1981, although demand had peaked in 1978. The refining industry in 1980 and 1981 was still operating under the guidance of old long-term outlooks that foresaw increasing demand. The initial downturn in demand was thought to be only temporary. New facilities to meet the expected future increase in demand were already under construction. Therefore, excess capacity continued to be added well beyond the year of peak demand.

Before the downturn was felt in the upstream segment of the business, it was, however, being detected in the refining sector. Demand for petroleum products had begun to slip. But it was not interpreted immediately as an extended downturn in demand.

However, in retrospect we know it was a major turning point. Demand for petroleum products in the U.S. fell for five consecutive years in response to the massive price increases of the mid- and late 1970s. Demand fell 3.616 million b/d, 19.2%, to 15.231 million b/d in 1983. But as stated before, refining capacity continued to increase through 1981. However, crude runs peaked in 1979 along with demand for petroleum products, and the refinery utilization rate began to fall.

With demand falling and refining capacity on the rise, a large and growing excess refining capacity developed in the United States and worldwide. The utilization rate in the U.S., which was as high as 90.9% in 1973, and averaged 86.6% from 1973 to 1979, dropped to 75% in 1980. As demand continued to fall, the rate dropped to extremely low and unprofitable levels. The rate of utilization fell below 70%: 67% in 1981, 65.8% in 1982 and 69.3% in 1983. Prior to the downturn, between 1973 and 1979, excess capacity ranged from 1.2 million b/d to 2.8 million b/d. This was mainly contingency capacity to

REFINERY RUNS BY DISTRICTS

Crude runs

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
					1,000 b/d					
East Coast	1,296	1,202	1,103	960	1,019	1,061	1,122	1,153	1,198	1,189
Appalachian Dist. 1	167	158	132	93	77	87	92	101	98	98
Total Dist. 1	1,454	1,334	1,196	1,037	1,106	1,153	1,223	1,251	1,298	1,287
Appalachian Dist. 2	51	54	51	53	58	60	54	—	—	—
Ill., Ind., Ky.*	2,063	1,803	1,714	1,798	1,784	1,777	1,847	1,930	1,944	1,927
Minn., Wisc., Dak.	238	229	251	253	282	285	294	287	307	312
Okla., Kan., Mo.	943	883	763	642	636	617	627	627	665	665
Total Dist. 2	3,295	2,969	2,779	2,746	2,760	2,739	2,822	2,844	2,916	2,904
Texas:										
Inland	445	469	456	474	499	472	472	470	480	508
Gulf Coast	3,142	2,829	2,726	2,801	2,780	2,750	2,990	2,909	3,021	3,026
Louisiana Gulf	2,085	2,030	1,941	1,862	2,012	1,972	2,162	2,230	2,261	2,380
N. La., Ark.	186	163	162	170	177	168	170	164	176	169
New Mexico	86	81	77	75	68	60	63	66	69	70
Total Dist. 3	5,944	5,572	5,362	5,382	5,536	5,422	5,857	5,839	6,007	6,153
Total Dist. 4	442	425	416	420	436	432	431	437	452	458
Total Dist. 5	2,347	2,171	2,021	2,100	2,206	2,256	2,383	2,483	2,573	2,598
Total U.S.	13,482	12,471	11,774	11,685	12,044	12,002	12,716	12,854	13,246	13,400

*Beginning in 1987 includes Appalachian Dist. 2.

Source: Energy Information Administration

allow for maintenance downtime and surges in product demand. After 1979, excess capacity jumped up to 4.5 million b/d in 1980 and to 6.1 million b/d in 1981 and 1982.

With excess refining capacity, refining margins and profits fell sharply. While earnings from exploration, drilling and production activities were still substantial, the refining sector was experiencing a period of low earnings and even losses for some operations.

The drop in demand also resulted in a change in the long-range perception and forecasts of petroleum product demand. Past expectations of product demand, increasing in step with the long-range growth in economic activity, and moving up 3–4%/year, were put to rest. Refiners recognized that the lower demand levels they were experiencing were not a temporary economic phenomenon. They realized that they could not simply wait for

demand to return to the previous growth trend. The refining industry saw that a capacity adjustment to lower demand levels was going to be required. Capacity would have to be reduced in order to increase the utilization rate, cut unit costs, and improve margins and profits

From the peak in 1981, annual average total distillation capacity moved down 17%, falling to 15.5 million b/d in 1986. This was a cut in capacity of 3.162 million b/d. The number of plants operating fell from 315 in 1981 to 192 in 1986, a drop of 123, and the total number of plants was down from 324 to 223, off 101. The number of plants temporarily shut down moved up to 24, and many plants were closed permanently.

Refining capacity was reduced, in order to close the gap between capacity and demand. The operating objective was to boost the utilization rate, reduce unit costs, improve margins and increase profitability.

The refining industry had historically operated in an atmosphere of ever-expanding refining capacity in response to demand for products. Adjusting their planning process to accommodate a shrinking industry was difficult. But a lean and efficient industry was essential if refinery margins and profitability were to improve.

Demand for petroleum products turned

around again in 1984, after prices had fallen sufficiently to slow the conservation effort. It has grown slowly and steadily since that time. Demand in 1989 was 17.325 million b/d, up 2.094 million b/d, 13.7%, since 1983. As a result of this upward shift in demand, refining capacity stopped its slide. In fact, refining capacity increased slightly in 1987 and 1988 due to the higher product demand. Average annual refining capacity increased 456,500 b/d.

But some excess capacity still existed. Restructuring and consolidation in the industry resulted in a reduction in capacity in 1989, down 260,500 b/d.

Most projections now call for improved demand in the future. And refining is a competitive business. Capacity is being adjusted as refiners attempt to define their most profitable market, increase market share, or make other adjustments to increase profitability.

The utilization rate, based on crude runs, has moved back up to a more acceptable level, at 82.6% in 1987, 83.2% in 1988 and 86.5% in 1989. Due to this improvement in the utilization rate, increased demand and improved efficiency, the financial conditions in the refining industry have improved markedly.

In 1985–86 the refining sector received a financial boost when a number of OPEC countries, led by Saudi Arabia, adopted net-back pricing. At that time the market was flooded with readily available crude oil, and crude costs plummeted.

The combination of lower crude costs and net-back pricing boosted refining margins substantially for a short period. Lower crude costs meant lower refinery feedstock costs. Crude costs fell faster than product costs. And for many refiners, net-back contracts virtually locked in a profit margin for every barrel of crude purchased and processed.

But with the OPEC adoption of new production quotas in late 1986 and 1987, and a tightening of the market, crude prices moved back up. Net-back pricing was scrapped by the crude producers. And refining margins disappeared.

However, in 1988 there was another surge in refining margins and refining profitability. Crude costs slid, lowering feedstock costs. And at the same time, demand continued to move up, increasing the refinery utilization rates, lowering unit production costs and improving operating margins. Increased demand boosted revenues. Product prices remained relatively stable, not falling along with crude costs, due to the increased product demand. All of this led to a sharp increase in refining profits.

Even with the excess capacity situation, capital expenditures for refining facilities remained relatively high over the 1981–85 period. A substantial portion of the investment was for upgrading capacity to produce a higher yield of lighter products and to handle heavier sour crude oils. The investments have been made because expectations are that in the future demand for lighter products will increase much faster than for the heavier fuel oil. Therefore, as overall distillation capacity was falling, upgrading capacity was increasing.

Illustrative of the shift to a greater demand for lighter products is the shift in resid and gasoline demand. In 1977, resid demand represented 16.7% of the demand barrel, and gasoline 38.9%. By 1985, this had shifted to resid only 7.6% and gasoline 43.4%. There was a slight reversal in this trend in 1986 as resid moved up to 8.7% and gasoline dropped to 43.2%. But when prices moved back up in 1987, resid fell to 7.6%. With lower prices, resid demand moved up in 1988 and the resid portion rose to 8%. In 1989, resid demand represented 7.9% of total demand and motor gasoline 42.3%. There are some signs that there could be a resurgence in resid demand if prices remain at a level low enough for resid to compete in the industrial and utility markets.

Nevertheless, over the past few years the investment has been concentrated more in upgrading and modernization. Capital spending for refining facilities moved up rapidly between 1978 and

1982, increasing from $1,551 million to $5,775 million. Over the next four years, during the downturn, refining outlays fell steadily to an estimated $2,073 million in 1986. The trend reversed in 1987 and investment increased to $2,180 million. It moved up again in 1988 to $2,874 million. Modernization continued and there was some additional capacity added. Capital expenditures in 1989 moved up sharply to $4,112 million.

REFINING MARGINS. One of the key financial indicators of the efficiency of refining operations is refining margins. Margins measure the difference between the value of the products from the refined barrel, and the combined cost of feedstocks and refining operations.

During the latter part of the expansion period, the total value of the refined barrel went from $14.73 in 1977, prior to the second large price hike, to $39.07 in 1981. The refiners acquisition cost of crude moved up from $11.96 in 1977 to $35.24 in 1981. Between 1977 and 1981, the net value to the refiner after subtracting refining costs was generally positive, averaging about $0.89/bbl.

However, in subsequent years, rapidly rising crude oil costs, coupled with rising refining costs, as the utilization rate fell, turned net margins negative. Falling product sales and high unit costs due to the low capacity utilization rate kept margins generally low or negative.

Increased demand and a higher refinery utilization rate helped refinery margins improve in 1985. And in 1986, low crude costs and an even higher utilization rate boosted margins again. Netback contracts with some major OPEC producers also helped some refiners.

When crude costs moved back up in 1987, operating margins again turned negative. A very competitive product market kept product prices from moving up. Therefore margins were squeezed when feedstock costs increased with the higher crude prices.

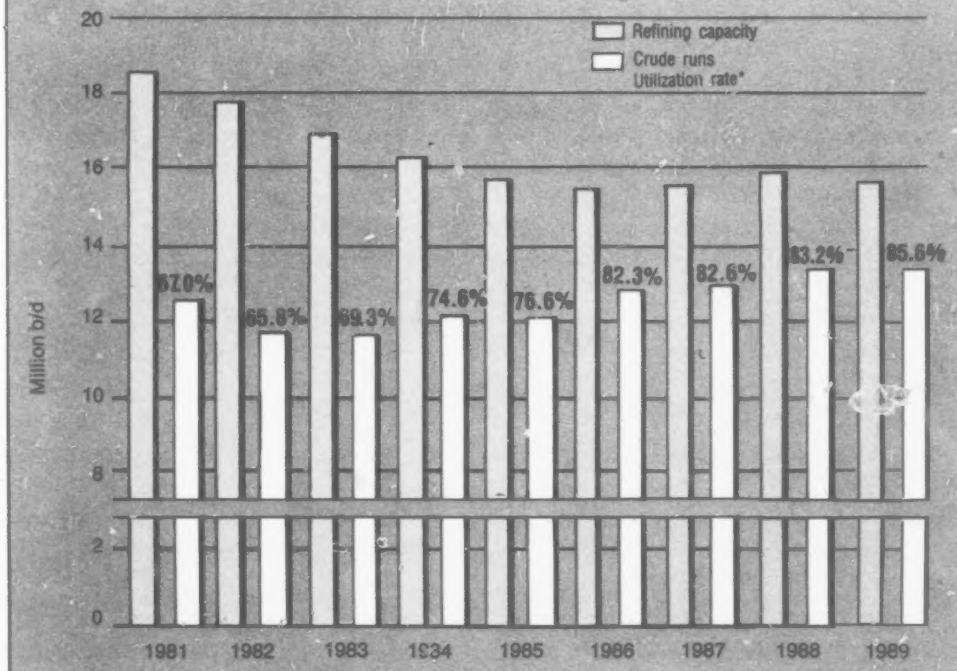
The situation was reversed in 1988. Falling crude prices reduced feedstock costs. At the same time, strong product demand enabled refiners to hold the line on product prices. This resulted in substantially improved margins. Margins started out the year negative but then rapidly moved up as crude prices fell. By the end of the second quarter of 1988, margins had reached some of the highest levels in recent years. Refining margins remained positive but were down somewhat at the end of 1988. Margins in 1989 stayed positive for most of the year and finished the year quite strong. The picture remained rather bright for the refining industry.

PETROCHEMICALS. Companies in the petrochemical industry posted record profits in 1988 and 1989. The continuing increase in economic activity boosted demand for petrochemical products. Increased demand and relatively stable prices boosted revenues substantially. Also with increased demand the utilization rate moved up and cut unit operating costs. This, combined with low or falling feedstock costs, increased margins and boosted profits.

The chemical/petrochemical industry activity closely follows the growth pattern of the overall economy. The U.S. economy is going through an unprecedented period of continuous growth, and demand for petrochemicals has followed. Rising demand helped eliminate the excess capacity problem that had depressed the industry for several years. However, success has led to additional capacity worldwide and a return in 1989 to a new period of excess petrochemical capacity.

Rapidly rising crude prices in the late 1970s and early 1980s had an impact on the petrochemical industry similar to the impact on refining. Increased crude prices meant increased feedstock costs for the petrochemical industry. This reduced margins and forced the industry to boost prices to recover the higher feedstock costs. The higher product prices tended to reduce demand.

U.S. REFINING CAPACITY AND CRUDE RUNS



	1981	1982	1983	1984	1985	1986	1987	1988	1989
Refining capacity	18.6	17.9	16.9	16.1	15.7	15.5	15.6	15.9	15.7
Crude runs	12.5	11.8	11.7	12.0	12.0	12.7	12.9	13.2	13.4

*Crude runs as percent of capacity.
Source: Energy Information Administration

Demand leveled off, and an excess capacity problem developed. Worldwide capacity additions had exceeded demand for several years. Capacity had been built up in the anticipation of ever-increasing demand. Besides capacity additions in the industrial countries, additional capacity has been added recently in the Middle East, aggravating this situation. Some of the OPEC countries have been investing in downstream facilities as part of their long range growth plans.

The estimated U.S. capacity utilization rate fell as low as 66% in 1982. In that year, higher product prices resulting from rising feedstock costs and slower growth in economic activity reduced demand for petrochemicals. This further aggravated the excess capacity situation.

Demand picked up in 1983 and 1984, increasing at an annual rate of about 7–8%. It stag-

nated in 1985–86, showing little net growth over that two-year span. But general worldwide economic growth in 1987 and 1988 again boosted demand. Growth over those two years is estimated at over 8% per year.

Capacity additions were held in check over this period, and therefore the utilization rate moved up sharply. It was estimated that in 1988, plants worldwide were operating at over 90% of capacity. However, recent capacity additions and some slowdown in demand may have markedly changed the rate in 1989 and into 1990. U.S. ethylene capacity was cut from the high of around 18.2 million metric tons per year in 1981 to 16.985 million metric tons in June 1988. This put capacity more in line with demand estimated at 16 million metric tons per year.

During the period of excess capacity, the petrochemical industry found itself trapped with sluggish demand and depressed margins. Feedstock costs were high. The utilization rate was low, increasing unit production costs. Demand was not increasing, and product prices were held low because of intense competition.

This situation had changed dramatically by 1987–88. Demand had risen substantially and was continuing up. Prices were firm due to increased demand and less excess capacity. The operating rates were up, reducing costs. And feedstock costs were relatively low due to low crude prices. As a result, petrochemical margins were up substantially, and good profits were being posted.

U.S. Gulf coast average cash margins for E/P mix were 2.72 ct./lb of ethylene produced back in 1985. This had moved up to over 20 ct./lb in 1988. Light naphtha cash margins were only 0.20 ct./lb of ethylene in 1985. This was up to over 25 ct./lb in 1988. Margins started out very strong in 1989 but then weakened substantially toward the end of the year. Margins for E/P mix fell 39% from January 1989 at 22.15 ct./lb to December 1989 at only 13.59 ct./lb. The average for the year was 20.3 ct./lb. The average for the first half of 1990 has stayed down and was 13.13 ct./lb. The same pattern was true for light naphtha. The margin dropped from 32.92 ct./lb of ethylene in January 1989 to 15.45 ct./lb in December, a decline of 53%. The average for the year was 25.67 ct./lb. For the first half of 1990, light naphtha margins averaged 17.34 ct./lb. Weaker demand and some excess capacity have led to lower margins.

There is a lot of optimism in the petrochemical industry. But the huge margins posted in past years have led to additional capacity being added. And this may result in another period of excess capacity in the 1990s. U.S. ethylene capacity moved up 7.5% from 17.786 million metric tons/year in 1989 to 19.122 million metric tons/year in 1990. Total world capacity also increased, moving up 7.8% to 54.043 million metric tons/year in 1990. The increase in the U.S. was one of the largest, but the other areas of the world also posted increases: Latin America +25.1%, Western Europe +1.9%, Asia Pacific +6.8%, and all other areas +20.9%. The concern about excess capacity may now be fact rather than expectation. The ability to profitably use this additional capacity will depend upon the rate of growth in economic activity.

OUTLOOK

The embargo on crude oil from Kuwait and Iraq has resulted in the loss of a substantial volume of crude oil and tight crude oil supplies in the world oil market. This has resulted in a sharp increase in crude oil prices throughout the world. It appears that prices will remain at a higher level as long as the conflict lasts.

If the conflict in the Middle East lasts for any length of time, this higher price level will begin to have an impact on demand for petroleum products, demand for energy, and the rate of economic growth.

Therefore the length of time this dispute continues will also have an impact on the refining

and petrochemical sectors of the oil industry. Higher crude oil prices result in higher feedstock costs for refining and petrochemical facilities and also result in higher product costs. Higher product prices can result in a reduction in product demand. The level of product demand determines the refinery and petrochemical throughput, and the refinery and petrochemical plant capacity utilization rate. This determines the unit costs of products. In addition, the higher cost of energy could slow economic growth which would also reduce product demand.

Higher crude oil and product oil prices generate more revenue for the industry. The additional revenues provide additional funds for investment in facility upgrading and expansion.

Therefore the length of time that this dispute lasts will also affect the downstream sector of the oil industry. At this time it is uncertain how long the crisis involving Iraq and Kuwait will last. The loss of this volume of crude oil will exert upward pressure on crude oil prices as long as the crisis continues. This makes it almost impossible to project with any certainty the one most likely trend in refining and petrochemical activity and investment.

Therefore, in this edition of the Oil Industry Outlook, three scenarios are being presented. The three scenarios vary in expectations of the length of time the crisis in the Persian Gulf will last. The length of time the oil crisis continues will determine the trend in the price of crude oil, and therefore the trends in economic activity, demand for oil and petrochemical products, oil industry revenues and refining and petrochemical investments and activities. To cover these possible variations three separate forecasts are presented. The forecast with the highest degree of probability is the one that comes closest to estimating the length of time it takes to finally resolve this issue in the Middle East, and for Iraqi and Kuwaiti oil to return to the market.

Following is a brief review of the key points of each scenario. They are discussed in more detail in earlier chapters.

Scenario I—The embargo of oil exported from Iraq and Kuwait continues for a period of 6–18 months. The vast majority of oil production in Iraq and Kuwait is shut in for the duration of the dispute. Oil production capacity in other OPEC areas is not affected by the dispute. Following the settlement of the dispute, production in Iraq and Kuwait is resumed at previous levels.

Scenario II—The embargo of oil exported from Iraq and Kuwait continues for a period of 18–30 months. The vast majority of oil production in Iraq and Kuwait is shut in for the extended duration of the dispute. Oil production capacity in other OPEC areas is not affected by the dispute. Following the settlement of the dispute, production in Iraq and Kuwait is resumed at previous levels.

Scenario III—The embargo of oil exported from Iraq and Kuwait continues for less than six months. The vast majority of oil production in Iraq and Kuwait is shut in during this period. Production capacity in other OPEC countries is not affected by this dispute. Following settlement of the dispute, production in Iraq and Kuwait is resumed at previous levels.

The major differences between the three scenarios is the length of time that the crisis continues and Iraqi and Kuwaiti oil is off the market. But even though the length of time until settlement of the dispute is the only apparent difference, these three scenarios will cause three distinct sets of conditions in the oil market. And the different market conditions will create differing projections of prices, petroleum product demand and investment, and level of operations in refining and petrochemicals.

SCENARIO I—With the sharp increase in crude oil prices the refiner acquisition cost of crude oil has also moved up. The composite refiner acquisition cost of crude oil will move up to $26.92/bbl in 1991, 20.1% above 1990 and up 49.8% from 1989. The average pump price of motor gasoline is expected to move up 19.7% in

1991 to $1.40/gal. Distillate home heating fuel oil is projected to move up 21.2%, to $1.20/gal in 1991. As a result of the much higher product prices, total U.S. demand for petroleum products will move up only 0.6%, to 17.29 million b/d in 1991.

After the dispute is settled in 1992, the crude costs will drop and the composite refiner acquisition cost of crude oil will fall 21.7%, to $21.10/bbl. The average pump price of motor gasoline will drop 17.9%, to $1.15/gal and distillate home heating fuel oil will fall 18.3%, to $0.98/gal. With lower product prices, total demand for petroleum products will move up 1.9%, to 17.62 million b/d.

Over the remainder of the forecast period the crude price and the refiner acquisition cost will move up gradually. The refiner acquisition cost will move up to $24.33/bbl in 1995. The average pump price for motor gasoline will move up to $1.27/gal and the price of home heating fuel oil will move up to $1.08/gal. Total product demand will climb to 18.37 million b/d. This will be up 1.18 million b/d from demand in 1990.

Total U.S. refining capacity will reverse directions and is projected to increase over the 1990–95 forecast period. The capacity additions will be made throughout the forecast period even though crude prices and demand will not be growing steadily. Total U.S. refining distillation capacity is expected to be increased 2.9%, to 16 million b/d in 1995. The increase in capacity will be less than the increase in demand, so it is likely that the refinery utilization rate will move up over the forecast period.

Refiners prefer a utilization rate of 85–90%. This rate is more efficient and profitable. Refinery crude runs and total input to distillation units will increase with demand. Crude runs will move up 6.8%, to 14.205 million b/d in 1995 and inputs to distillation units will increase to 14.365 million b/d in 1995. Most of the increase in demand will be met by increased domestic product production. As a result the refinery utilization rate will move up. The utilization rate will increase steadily over the next five years and is projected to increase to close to 90% in 1995.

Increased demand could also be supplied by product imports. However, refiners prefer to utilize existing refining capacity if possible. Therefore product imports are not expected to move up as rapidly as demand over the forecast period, increasing only 75,000 b/d, 3.3% by 1995. The level of product imports will depend upon the relative cost of imported products compared to the domestic cost of production.

Crude imports will move up much faster than either demand or refinery crude runs. Crude imports will move up to 7.655 million b/d in 1995, an increase of 27.3% over the 1990 level. The rapid increase in crude imports means refiners will be processing a great deal more foreign crude in the future years.

Capital spending is expected to remain relatively high in the future to meet changing product demand patterns and changing crude qualities. It will be essential to have the ability to handle the heavier crudes and to be able to upgrade the output and produce a greater yield of lighter products. This will be essential for long term profitability in the refining industry. Even though resid demand is expected to increase over the long run, lighter products will be the most profitable for refiners.

Capital spending in the refining industry is projected to move up throughout the forecast period. The increased outlays will be for the added capacity modernization and increased upgrading capacity. New environmental rules may also result in increased investment for new facilities.

Capital spending in the refining industry is projected to increase 13.4% over the forecast period, moving up to $4.665 billion in 1995.

SCENARIO II—With the sharp increase in crude oil prices the refiner acquisition cost of crude oil has also moved up. The composite refiner acquisition cost of crude oil will move up to $26.92/bbl in 1991, 20.1% above 1990 and up

49.8% from 1989. The average pump price of motor gasoline is expected to move up 19.7% in 1991, to $1.40/gal. Distillate home heating fuel oil is projected to move up 21.2%, to $1.20/gal in 1991. As a result of the much higher product prices, total U.S. demand for petroleum products will move up only 0.6%, to 17.29 million b/d in 1991.

The refiner acquisition cost of crude oil will move up again in 1992 due to the continuing tight oil supply market. It will move up to $29.62/bbl for 1992. The price of motor gasoline will move up to $1.50/gal and distillate will move up to $1.25/gal. Product demand will move up a sluggish 0.6%, to 17.41 million b/d in 1992.

After the dispute is settled in 1993, the crude costs will drop and the composite refiner acquisition cost of crude oil will fall 30.9%, to $20.48/bbl. The average pump price of motor gasoline will drop 23.3%, to $1.15/gal and distillate home heating fuel oil will fall 21.6%, to $0.98/gal. With lower product prices total demand for petroleum products will move up 1.7%, to 17.71 million b/d.

Over the remaining two years of the forecast period the crude price and the refiner acquisition cost will move up gradually. The refiner acquisition cost will move up to $23.65/bbl in 1995. The average pump price for motor gasoline will move up to $1.25/gal and the price of home heating fuel oil will move up to $1.06/gal. Total product demand will climb to 18.21 million b/d. This will be up 1.02 million b/d from demand in 1990.

Total U.S. refining capacity will reverse directions and is projected to increase over the 1990–95 forecast period. The capacity additions will be made throughout the forecast period even though crude prices and demand will not be growing steadily. Total U.S. refining distillation capacity is expected to be increased 2.9%, to 16 million b/d in 1995. The increase in capacity will be less than the increase in demand, so it is likely that the refinery utilization rate will move up over the forecast period.

Refiners prefer a utilization rate of 85–90%. This rate is more efficient and profitable. Refinery crude runs and total input to distillation units will increase with demand. Crude runs will move up 5.9%, to 14.085 million b/d in 1995 and inputs to

distillation units will increase to 14.245 million b/d in 1995. Most of the increase in demand will be met by increased domestic product production. As a result the refinery utilization rate will move up. The utilization rate will increase steadily over the next five years and is projected to increase to 89% in 1995.

Increased demand could also be supplied by product imports. However, refiners prefer to utilize existing refining capacity if possible. Therefore product imports are not expected to move up as rapidly as demand over the forecast period, increasing only 55,000 b/d, 2.4% by 1995. The level of product imports will depend upon the relative cost of imported products compared to the domestic cost of production.

Crude imports will move up much faster than either demand or refinery crude runs. Crude imports will move up to 7.46 million b/d in 1995, an increase of 24% over the 1990 level. The rapid increase in crude imports means refiners will be processing a great deal more foreign crude in the future years.

Capital spending is expected to remain relatively high in the future to meet changing product demand patterns and changing crude qualities. It will be essential to have the ability to handle the heavier crudes and to be able to upgrade the output and produce a greater yield of lighter products. This will be essential for long-term profitability in the refining industry. Even though resid demand is expected to increase over the long run, lighter products will be the most profitable for refiners.

Capital spending in the refining industry is projected to move up throughout the forecast period. The increased outlays will be for the added capacity modernization and increased upgrading

capacity. New environmental rules may also result in increased investment for new facilities.

Capital spending in the refining industry is projected to increase 11.9% over the forecast period, moving up to $4.6 billion in 1995.

SCENARIO III—With the sharp increase in crude oil prices the refiner acquisition cost of crude oil has also moved up. However, the prices will fall as soon as the Middle East conflict is settled. It is expected that the conflict will be over by the end of 1990 or early 1991. After the dispute is settled in 1991, the crude costs will drop and the composite refiner acquisition cost of crude oil will fall 6.7%, to $19.65/bbl. The average pump price of motor gasoline will drop 4.3%, to $1.10/gal and distillate home heating fuel oil will fall 5.1%, to $0.93/gal. With lower product prices, total demand for petroleum products will move up 1.4%, to 17.53 million b/d.

Over the remainder of the forecast period the crude price and the refiner acquisition cost will move up gradually. The refiner acquisition cost will move up to $25.13/bbl in 1995. The average pump price for motor gasoline will move up to $1.30/gal and the price of home heating fuel oil will move up to $1.10/gal. Total product demand will climb to 18.645 million b/d. This will be up 1.355 million b/d from demand in 1990.

Total U.S. refining capacity will reverse directions and is projected to increase over the 1990–95 forecast period. The capacity additions will be made throughout the forecast period even though crude prices and demand will not be growing steadily. Total U.S. refining distillation capacity is expected to be increased 3.4%, to 16.08 million b/d in 1995. The increase in capacity will be less than the increase in demand, so it is likely that the refinery utilization rate will move up over the forecast period.

Refiners prefer a utilization rate of 85–90%. This rate is more efficient and profitable. Refinery crude runs and total input to distillation units will increase with demand. Crude runs will move up 7.8%, to 14.42 million b/d in 1995 and inputs to distillation units will increase to 14.58 million b/d in 1995. Most of the increase in demand will be met by increased domestic product production. As a result the refinery utilization rate will move up. The utilization rate will increase steadily over the next five years and is projected to increase to 90.7% in 1995.

Increased demand could also be supplied by product imports. However, refiners prefer to utilize existing refining capacity if possible. Therefore product imports are not expected to move up as rapidly as demand over the forecast period, increasing only 100,000 b/d, 4.3%, by 1995. The level of product imports will depend upon the relative cost of imported products compared to the domestic cost of production.

Crude imports will move up much faster than either demand or refinery crude runs. Crude imports will move up to 7.985 million b/d in 1995, an increase of 27.8% over the 1990 level. The rapid increase in crude imports means refiners will be processing a great deal more foreign crude in the future years.

Capital spending is expected to remain relatively high in the future to meet changing product demand patterns and changing crude qualities. It will be essential to have the ability to handle the heavier crudes and to be able to upgrade the output and produce a greater yield of lighter products. This will be essential for long-term profitability in the refining industry. Even though resid demand is expected to increase over the long run, lighter products will be the most profitable for refiners.

Capital spending in the refining industry is projected to move up through the forecast period. The increased outlays will be for the added capacity modernization and increased upgrading capacity. New environmental rules may also result in increased investment for new facilities.

Capital spending in the refining industry is projected to increase 17.9% over the forecast period, moving up to $4.72 billion in 1995.

Refiners at present are operating quite

profitably. Increased profitability in the future will depend upon increased demand and increased refining operating efficiency.

Over the forecast period, crude oil costs are expected to move up faster than product prices. This will somewhat close the gap between feedstock costs and product values. But profitability could remain fairly high. The increased utilization rate will reduce unit operating costs. And increased demand will boost total revenues.

Refiners will not have the luxury of netback deals to insure improved margins during the forecast period. However, several refiners have worked out or shown interest in joint agreements with producing countries. This type of renewed vertical integration could also help boost profits, by removing some of the uncertainty and allowing for more efficient planning.

The future for the petrochemical industry also appears favorable. Demand is expected to grow at an annual rate of 4–5%. The one problem that may arise during the forecast period is the development of excess capacity in the early 1990s. The large additions in 1990 indicate that this may already be taking place. However, some of the increase may be offset by the idling of some older capacity. If demand does not keep pace with these additions, then excess capacity will reduce operating rates. This would reduce margins and profitability.

Another related problem that could arise is increased foreign competition. Demand has increased in Europe and elsewhere in the world. This may result in substantial capacity being added overseas. The additions in 1990 noted may also be the start of increasing non-U.S. capacity. In addition, there are the new petrochemical export facilities in the Middle East that are producing low-cost product intended for export. These facilities have very low feedstock costs and in some cases have government subsidies.

The result could be low-cost foreign petrochemicals competing in the U.S. market and depressing prices. This has resulted in some petrochemical producers planning to move away from the feedstock intensive commodities business and shift towards the higher value-added specialty products markets.

Capital spending by the U.S. oil companies on petrochemical facilities is expected to increase 15–18% over the forecast period to $3.105–3.18 billion in 1995.

Despite the potential problems associated with excess capacity and the environment, the expectations are for future growth and increased profit potential over the forecast period.

REFINING AND PETROCHEMICALS KEYS TO THE FUTURE SCENARIO I

1. Demand for petroleum products in the U.S. will increase throughout the forecast period. Demand growth will be slow in 1991 due to the higher product prices, Demand will be up 6.9% by 1995, an increase of 1.18 million b/d to 18.37 million b/d.

2. U.S. refining capacity will move up along with demand and crude runs. Capacity additions will not be affected by the temporary increase in crude prices in 1991. Capacity will be expanded to 16 million b/d by 1995, up 456,000 b/d, an increase of 2.9%.

3. Increased crude runs to meet demand will boost the refinery utilization rate to a more profitable level. Crude runs will increase more than capacity. Over the forecast period the rate will move up from 86% to close to 90%.

4. Crude costs will move up slightly faster than product prices. However, increased demand and lower refinery operating costs should help maintain margins.

5. Product imports will move up, but not as much as demand. Most of the increase in demand will be supplied by domestic refineries. Product imports will increase 3.3%, to 2.365 million b/d in 1995. Product imports could be higher if import prices are competitive.

6. Petrochemical demand will continue to move up over the forecast period. Continued growth in economic activity will boost product demand. Worldwide plans to add to petrochemical capacity could result in a new excess capacity problem during the forecast period.

7. The need for additional capacity and capacity upgrading and modernization will boost capital spending for both refining and petrochemicals. Spending on refining will move up 13.4% by 1995. Spending on petrochemicals will be up 16.5% by 1995.

8. Environmental concerns could result in additional operating problems and additional investment requirements for the refining and petrochemical industries.

THE OUTLOOK — REFINING & PETROCHEMICALS
SCENARIO — I

	1989	1990	1991	1992	1993	1994	1995	Change 1990 to 1995	% change 1990 to 1995
U.S. domestic demand									
(thousand barrels/day)	17,325	17,190	17,290	17,620	17,900	18,135	18,370	+1,180	+ 6.9
U.S. refining:									
(thousand barrels/day)									
Refining capacity	15,701	15,544	15,590	15,665	15,790	15,895	16,000	+456	+2.9
Crude runs	13,401	13,297	13,375	13,625	13,845	14,025	14,205	+910	+6.8
Input to distillation units	13,547	13,456	13,525	13,775	14,000	14,180	14,365	+909	+6.8
Refinery utilization rate (%)	86.3	86.6	86.8	87.9	88.7	89.2	89.8	+3.2	+3.7
U.S. imports									
(thousand barrels/day)									
Crude imports (ex. SPR)	5,788	6,015	6,240	6,725	7,130	7,410	7,655	+1,640	+27.3
Crude imports—% of crude runs	43.2	45.2	46.7	49.4	51.5	52.8	53.9	+8.7	+19.2
Product imports	2,217	2,290	2,300	2,315	2,330	2,350	2,365	+7.5	+3.3
Product imports—% of demand	12.8	13.3	13.3	13.1	13.0	13.0	12.9	−0.4	−3.0
CAPITAL SPENDING									
($ million)									
Refining	3,167	4,112	4,625	4,340	4,450	4,565	4,665	+553	+13.4
Petrochemical	2,713	2,699	2,725	2,790	2,885	3,005	3,145	+446	+16.5
PRICES									
U.S. refinery acquisition cost:									
($/barrel)									
Domestic crude	17.88	21.49	26.85	21.00	22.05	23.10	24.25	+2.76	+12.8
Imported crude	18.08	21.70	27.00	21.20	22.30	23.40	24.40	+2.70	+12.4
Composite price of crude	17.97	21.59	26.92	21.10	22.18	23.26	24.33	+2.74	+12.7
Motor gasoline pump price ($/gallon)	1.06	1.17	1.40	1.15	1.17	1.22	1.27	+0.10	+8.5
Distillate fuel oil-home heating ($/gallon)	0.90	0.99	1.20	0.98	0.99	1.04	1.08	+0.09	+9.1

REFINING AND PETROCHEMICALS KEYS TO THE FUTURE SCENARIO II

1. Demand for petroleum products in the U.S. will increase throughout the forecast period. Demand growth will be slow in 1991 and 1992 due to the higher product prices. Demand will be up 5.9% by 1995, an increase of 1.02 million b/d to 18.21 million b/d.

2. U.S. refining capacity will move up along with demand and crude runs. Capacity additions will not be affected by the temporary increase in crude prices in 1991. Capacity will be expanded to 16 million b/d by 1995, up 456,000 b/d, an increase of 2.9%.

3. Increased crude runs to meet demand will boost the refinery utilization rate to a more profitable level. Crude runs will increase more than capacity. Over the forecase period the rate will move up from 86% to 89%.

4. Crude costs will move up slightly faster than product prices. However, increased demand and lower refinery operating costs should help maintain margins.

5. Product imports will move up, but not as much as demand. Most of the increase in demand will be supplied by domestic refineries. Product imports will increase 2.4%, to 2.345 million b/d in 1995. Product imports could be higher if import prices are competitive.

6. Petrochemical demand will continue to move up over the forecast period. Continued growth in economic activity will boost product demand. Worldwide plans to add to petrochemical capacity could result in a new excess capacity problem during the forecast period.

7. The need for additional capacity and capacity upgrading and modernization will boost capital spending for both refining and petrochemicals. Spending on refining will move up 11.9% by 1995. Spending on petrochemicals will be up 15% by 1995.

8. Environmental concerns could result in additional operating problems and additional investment requirements for the refining and petrochemical industries.

THE OUTLOOK — REFINING & PETROCHEMICALS
SCENARIO — II

	1989	1990	1991	1992	1993	1994	1995	Change 1990 to 1995	% change 1990 to 1995
U.S. domestic demand									
(thousand barrels/day)	17,325	17,190	17,290	17,410	17,710	17,960	18,210	+1,020	+ 5.9
U.S. refining:									
(thousand barrels/day)									
Refining capacity	15,701	15,544	15,590	15,645	15,780	15,890	16,000	+456	+2.9
Crude runs	13,401	13,297	13,375	13,465	13,700	13,895	14,085	+790	+5.9
Input to distillation units	13,547	13,456	13,530	13,615	13,855	14,050	14,245	+789	+5.8
Refinery utilization rate (%)	86.3	86.6	86.8	87.0	87.8	88.4	89.0	+2.4	+2.8
U.S. imports									
(thousand barrels/day)									
Crude imports (ex. SPR)	5,788	6,015	6,240	6,450	6,880	7,195	7,460	+1,445	+24.0
Crude imports—% of crude runs	43.2	45.2	46.7	47.9	50.2	51.8	53.0	+7.8	+17.3
Product imports	2,217	2,290	2,300	2,305	2,310	2,325	2,345	+55	+2.4
Product imports—% of demand	12.8	13.3	13.3	13.2	13.0	12.9	12.9	−0.4	−3.0
CAPITAL SPENDING									
($ million)									
Refining	3,167	4,112	4,625	5,090	4,285	4,455	4,600	+488	+11.9
Petrochemical	2,713	2,699	2,725	3,000	2,780	2,930	3,105	+406	+15.0
PRICES									
U.S. refinery acquisition cost:									
($/barrel)									
Domestic crude	17.88	21.49	26.85	29.55	20.40	22.00	23.60	+2.11	+9.8
Imported crude	18.08	21.70	27.00	29.70	20.55	22.10	23.70	+2.00	+9.2
Composite price of crude	17.97	21.59	26.92	29.62	20.48	22.05	23.65	+2.06	+9.5
Motor gasoline pump price ($/gallon)	1.06	1.17	1.40	1.50	1.15	1.20	1.25	+0.08	+6.8
Distillate fuel oil-home heating ($/gallon)	0.90	0.99	1.20	1.25	0.98	1.02	1.06	+0.07	+7.1

REFINING AND PETROCHEMICALS KEYS TO THE FUTURE SCENARIO III

1. Demand for petroleum products in the U.S. will increase throughout the forecast period. Demand growth will be boosted by relatively low prices and increased economic activity. Demand will be up 7.8% by 1995, an increase of 1.355 million b/d, to 18.645 million b/d.

2. U.S. refining capacity will move up along with demand and crude runs. Capacity additions will not be affected by the level of crude prices. Capacity will be expanded to 16.08 million b/d by 1995, up 536,000 b/d, an increase of 3.4%.

3. Increased crude runs to meet demand will boost the refinery utilization rate to a more profitable level. Crude runs will increase more than capacity. Over the forecase period the rate will move up from 87% to 90.7%.

4. Crude costs will move up slightly faster than product prices. However, increased demand and lower refinery operating costs should help maintain margins.

5. Product imports will move up, but not as much as demand. Most of the increase in demand will be supplied by domestic refineries. Product imports will increase 4.3%, to 2.4 million b/d in 1995. Product imports could be higher if import prices are competitive.

6. Petrochemical demand will continue to move up over the forecast period. Continued growth in economic activity will boost product demand. Worldwide plans to add petrochemical capacity could result in a new excess capacity problem during the forecast period.

7. The need for additional capacity and capacity upgrading and modernization will boost capital spending for both refining and petrochemicals. Spending on refining will move up 17.9% by 1995. Spending on petrochemicals will be up 17.6% by 1995.

8. Environmental concerns could result in additional operating problems and additional investment requirements for the refining and petrochemical industries.

THE OUTLOOK — REFINING & PETROCHEMICALS
SCENARIO — III

	1989	1990	1991	1992	1993	1994	1995	Change 1990 to 1995	% change 1990 to 1995
U.S. domestic demand									
(thousand barrels/day)	17,325	17,290	17,530	17,855	18,135	18,385	18,645	+1,355	+ 7.8
U.S. refining:									
(thousand barrels/day)									
Refining capacity	15,701	15,544	15,590	15,735	15,855	15,965	16,080	+536	+3.4
Crude runs	13,401	13,374	13,560	13,810	14,025	14,220	14,420	+1,046	+7.8
Input to distillation units	13,547	13,533	13,710	13,960	14,180	14,375	14,580	+1,047	+7.7
Refinery utilization rate (%)	86.3	87.1	87.9	88.7	89.4	90.0	90.7	+3.6	+4.1
U.S. imports									
(thousand barrels/day)									
Crude imports (ex. SPR)	5,788	6,250	6,550	7,050	7,405	7,705	7,985	+1,735	+27.8
Crude imports—% of crude runs	43.2	46.7	48.3	51.0	52.8	54.2	55.4	+8.7	+18.6
Product imports	2,217	2,300	2,330	2,345	2,360	2,380	2,400	+100	+4.3
Product imports—% of demand	12.8	13.3	13.3	13.1	13.0	12.9	12.9	−0.4	−3.0
CAPITAL SPENDING									
($ million)									
Refining	3,167	4,004	4,280	4,390	4,500	4,620	4,720	+716	+17.9
Petrochemical	2,713	2,704	2,750	2,830	2,920	3,040	3,180	+476	+17.6
PRICES									
U.S. refinery acquisition cost:									
($/barrel)									
Domestic crude	17.88	20.93	19.55	21.70	22.80	23.95	25.10	+4.17	+19.9
Imported crude	18.08	21.15	19.75	21.85	22.90	24.00	25.15	+4.00	+18.9
Composite price of crude	17.97	21.07	19.65	21.78	22.85	23.98	25.13	+4.06	+19.3
Motor gasoline pump price ($/gallon)	1.06	1.15	1.10	1.15	1.20	1.25	1.30	+0.15	+13.0
Distillate fuel oil-home heating ($/gallon)	0.90	0.98	0.93	0.98	1.02	1.06	1.10	+0.12	+12.2

TRANSPORTATION

The conflict in the Middle East will have an impact on all sectors of the worldwide oil and gas industry, and this includes the transportation segment of the industry. The embargo on exports from Kuwait and Iraq has removed approximately 4.2 million b/d from world trade movements. But this is not the only impact on the transportation sector. The loss of this volume of oil from the market has driven up the price of crude oil. The increase in price

will have an impact on worldwide and domestic demand. This, in turn, will determine the level of worldwide and domestic U.S. imports and therefore the volume of transport of crude.

In addition, the danger of a war breaking out in the Persian Gulf area has driven up the cost of tanker transport. This will add to the increase in prices that will be paid for imported oil. The length of time that this dispute lasts will be one factor that determines the outlook for transportation in the worldwide and U.S. oil and gas industry.

The changes in the transportation portion of the oil and gas industry are related to the location and volume of production and the location and level of consumption. The location and volume of crude oil and natural gas production are constantly changing throughout the world and within the U.S. The level and location of consumption is also changing with changes in economic activity. These changes also vary throughout the world and within the United States. Over the past ten years the changes have been quite dramatic.

The level of activity in the transport sector is dependent upon the volume and location of the crude oil, petroleum products or natural gas to be moved. With the location of production, processing, and consumption continually changing, distribution patterns are constantly changing. Shifting distribution patterns change transport needs and operations, even if volumes are not increasing. This is true for all aspects of transport: pipelines, water going vessels, tanker trucks, or trains.

REVIEW

Over the past 10 to 15 years substantial changes have been posted in the level of production, consumption, and import/export levels, of both crude oil and natural gas.

Many of the changes were very dramatic. Demand for petroleum products in the U.S. dropped 3.616 million b/d between 1978 and 1982. Then between 1982 and 1989 the trend in demand reversed and it moved up, increasing 2.094 million b/d. These large swings in demand for products obviously had an impact on product distribution patterns and transport requirements in the U.S.

On the production side of the industry, the swings were also dramatic. With the rapid rise in prices, U.S. output of crude oil moved up from 8.132 million b/d in 1976 to a recent peak of 8.971 million b/d in 1985. Then after prices plummeted in 1986, crude production started to slide, and by 1989 had slipped to an average of 7.813 million b/d. Over this period, Alaskan production moved up steadily from 173,000 b/d in 1976 to 2.017 million b/d in 1988. However, this may have also reversed, Alaskan production in 1989 fell to 1.874 million b/d.

Import levels also went through some large changes over this period. Crude oil imports moved up from 3.244 million b/d in 1973 to 6.615 million b/d in 1977 and 6.519 million b/d in 1979. Then, as U.S. demand slipped, crude imports fell sharply to 3.201 million b/d in 1985. These huge changes in import levels had a tremendous impact on the international crude oil tanker business. And the dramatic shifting in import levels has not ceased. Imports have been moving up rapidly since 1985, rising to 5.843 million b/d in 1989.

These sharp swings in product demand, crude production, and imports have resulted in substantial alterations in distribution and transport operations and facilities.

Natural gas has also gone through some sharp shifts in consumption, production and imports. U.S. consumption of natural gas ranged from 19.4 to 20.2 tcf between 1975 and 1981. Consumption started to fall in 1982 and dropped as low as 16.2 tcf in 1986. But with lower prices and increased economic activity, this trend also reversed. Natural gas consumption is now on the rise, and reached 18.812 tcf in 1989.

TOTAL CRUDE PETROLEUM AND PETROLEUM PRODUCTS CARRIED IN DOMESTIC TRANSPORTATION

By mode of transportation
(Billions of ton miles)

Year	Total crude and products Ton miles	PIPELINES		WATER CARRIERS		MOTOR CARRIERS*		RAILROADS	
		Ton miles	Percent of total	Ton miles	Percent of total	Ton miles	Percent of total	Ton miles	Percent of total
1972	838.8	475.8	56.73	330.0	39.34	23.0	2.74	10.0	1.19
1973	843.6	507.0	60.10	296.8	35.18	25.0	2.96	14.8	1.76
1974	847.7	506.0	59.69	297.0	35.04	29.0	3.42	15.7	1.85
1975	846.7	507.0	59.88	298.0	35.20	27.6	3.26	14.1	1.66
1976	867.7	515.0	59.35	306.9	35.37	32.5	3.75	13.3	1.53
1977	923.4	546.0	59.13	333.3	36.09	29.6	3.21	14.5	1.57
1978	1,160.2	585.8	50.49	530.6	45.73	30.6	2.64	13.2	1.14
1979	1,174.8	608.3	51.78	522.9	44.51	30.1	2.56	13.5	1.15
1980	1,245.3	588.2	47.24	617.8	49.61	26.8	2.15	12.5	1.00
1981	1,218.4	563.7	46.27	617.2	50.66	24.9	2.04	12.6	1.03
1982	1,218.2	565.7	46.44	616.9	50.64	22.7	1.86	12.9	1.06
1983	1,223.5	556.1	45.45	630.5	51.53	25.1	2.05	11.8	0.97
1984	1,180.2	568.1	48.14	570.7	48.36	29.2	2.47	12.2	1.03
1985	1,195.5	564.3	47.20	590.4	49.39	28.7	2.40	12.1	1.01
1986	1,187.8	577.9	48.65	568.1	47.83	29.7	2.50	12.1	1.02
1987	1,195.8	586.8	49.07	566.5	47.37	30.4	2.54	12.1	1.01

TOTAL CRUDE PETROLEUM CARRIED IN DOMESTIC TRANSPORTATION

By mode of transportation
(Billions of ton miles)

Year	Total crude Ton miles	PIPELINES		WATER CARRIERS		MOTOR CARRIERS*		RAILROADS	
		Ton miles	Percent of total	Ton miles	Percent of total	Ton miles	Percent of total	Ton miles	Percent of total
1972	362.0	284.5	78.6	76.0	21.0	1.0	0.3	0.5	0.1
1973	363.2	302.0	83.1	58.8	16.1	1.3	0.4	1.1	0.4
1974	358.9	303.0	84.4	53.0	14.3	1.3	0.4	1.6	0.4
1975	331.5	288.0	86.9	40.6	12.2	1.4	0.4	1.5	0.5
1976	343.8	303.0	88.1	37.8	11.0	2.1	0.6	0.9	0.3
1977	392.5	326.6	83.2	63.1	16.1	2.0	0.5	0.8	0.2
1978	623.5	359.5	57.7	261.3	41.9	2.0	0.3	0.7	0.1
1979	640.6	372.2	58.1	265.5	41.4	2.3	0.4	0.6	0.1
1980	753.0	362.6	48.2	387.4	51.4	2.5	0.3	0.5	0.1
1981	740.7	333.1	45.0	404.9	54.6	2.2	0.3	0.5	0.1
1982	770.2	335.1	43.5	432.7	56.2	2.0	0.2	0.4	0.1
1983	806.1	332.4	41.2	471.2	58.5	2.0	0.2	0.5	0.1
1984	748.4	333.0	44.5	412.6	55.1	2.2	0.3	0.6	0.1
1985	786.2	334.4	42.5	449.2	57.2	1.8	0.2	0.8	0.1
1986	751.3	335.2	44.6	413.6	55.1	1.7	0.2	0.8	0.1
1987	767.3	341.5	44.5	423.3	55.2	1.6	0.2	0.9	0.1

TOTAL PETROLEUM PRODUCTS CARRIED IN DOMESTIC TRANSPORTATION

By mode of transportation
(Billions of ton miles)

Year	Total petroleum products Ton miles	PIPELINES		WATER CARRIERS		MOTOR CARRIERS*		RAILROADS	
		Ton miles	Percent of total	Ton miles	Percent of total	Ton miles	Percent of total	Ton miles	Percent of total
1972	476.8	191.3	40.1	254.0	53.3	22.0	4.6	9.5	2.0
1973	480.4	205.0	42.7	238.0	49.5	23.7	4.9	13.7	2.9
1974	488.8	203.0	41.5	244.0	49.9	27.7	5.7	14.1	2.9
1975	515.2	219.0	42.5	257.4	50.0	26.2	5.1	12.6	2.4
1976	523.9	212.0	40.5	269.1	51.4	30.4	5.8	12.4	2.3
1977	530.9	219.4	41.3	270.2	50.9	27.6	5.2	13.7	2.6
1978	536.7	226.3	42.2	269.3	50.2	28.6	5.3	12.5	2.3
1979	534.2	236.1	44.2	257.4	48.2	27.8	5.2	12.9	2.4
1980	492.3	225.6	45.8	230.4	46.8	24.3	5.0	12.0	2.4
1981	477.7	230.6	48.3	212.3	44.4	22.7	4.8	12.1	2.5
1982	448.0	230.6	51.5	184.2	41.1	20.7	4.6	12.5	2.8
1983	417.4	223.7	53.6	159.3	38.2	23.1	5.5	11.3	2.7
1984	431.8	235.1	54.4	158.1	36.6	27.0	6.3	11.6	2.7
1985	409.3	229.9	56.2	141.2	34.5	26.9	6.6	11.3	2.7
1986	436.5	242.7	55.6	154.5	35.4	28.0	6.4	11.3	2.6
1987	428.5	245.3	57.2	143.2	33.4	28.8	6.7	11.2	2.6

*Estimate

Source: Association of Oil Pipelines

WORLD TANKER FLEET* BY AGE, 10,000 DWT AND OVER

(As at year end — in Th.DWT)

Year built	1973 & earlier		1974-1978		1979-1983		1984-1988		Total	
Size group DWT	No.	DWT	No.	DWT	No.	DWT	No.	DWT	No.	DWT
10,000/16,499	83	1,136.3	65	907.7	67	875.3	66	928.1	281	3,847.4
16,500/24,999	172	3,640.5	68	1,466.6	80	1,585.3	32	644.3	352	7,336.7
25,000/29,999	86	2,390.9	57	1,596.3	55	1,504.6	47	1,335.0	245	6,906.8
30,000/39,999	109	3,752.9	195	6,578.5	109	3,886.3	61	2,291.2	474	16,508.9
40,000/49,999	27	1,252.6	9	393.8	43	1,919.0	57	2,551.3	136	6,116.7
50,000/59,999	25	1,353.5	25	1,403.7	63	3,523.3	10	575.2	123	6,855.7
60,000/69,999	22	1,454.7	13	849.6	56	3,562.6	31	1,988.4	122	7,855.3
70,000/79,999	41	3,041.1	15	1,181.0	36	2,878.2	8	615.8	100	7,716.1
80,000/99,999	39	3,488.1	111	9,792.3	59	5,237.0	62	5,331.8	271	23,849.2
100,000/124,999	35	3,896.7	49	5,783.3	8	890.5	23	2,465.5	115	13,036.0
125,000/159,999	29	4,020.4	121	16,795.9	10	1,380.9	11	1,524.1	171	23,721.3
160,000/199,999	4	674.9	17	3,001.8	6	1,077.2	—	—	27	4,753.9
200,000/249,999	42	9,541.8	57	13,154.4	1	221.2	15	3,504.5	115	26,421.9
250,000/319,999	36	9,560.7	173	47,099.8	11	3,139.6	13	3,303.8	233	63,103.9
320,000/399,999	—	—	31	11,031.1	4	1,500.7	—	—	35	12,531.8
400,000 & over	—	—	22	9,624.5	1	546.2	—	—	23	10,170.7
Total	**750**	**49,205.1**	**1,028**	**130,660.3**	**609**	**33,807.9**	**436**	**27,059.0**	**2,823**	**240,732.3**
TOTAL WORLD†									**2,923**	**243,472.4**

*Only the Commercial Fleet is included. †Including government-owned tankers.
Note: Figures are individually rounded.
Source: OPEC Statistical Bulletin

Marketed production in the United States followed a somewhat similar pattern. Domestic marketed production fell from 20.2 tcf in 1980 to 16.8 tcf in 1986. Domestic production has moved up the last few years and reached 17.955 tcf in 1989.

Imports of natural gas have also changed substantially. Imports averaged around 950 bcf from 1974 to 1985. Imports fell to 750 bcf in 1986. But then, along with the increase in U.S. consumption, imports moved up to 993 bcf in 1987, 1,294 bcf in 1988, and 1,382 bcf in 1989.

Changes in the location of production and consumption have accompanied these sharp swings in volume. And all of these changes have required adjustments in transport. These frequent changes end up requiring additional new investment in the transport sector of the oil and gas industry. Investment has continued at a good pace even though activity levels have changed dramatically. The new investment encompassed additions and changes in the capacity of all forms of transport: pipelines, water carriers, motor carriers and railroad cars.

Reviewing transport statistics shows how the traffic has changed in volume and shifted between types of carriers. The total ton miles of crude oil and petroleum products carried in U.S. domestic transportation moved up steadily from 1972 through 1980. During this period it increased 48.5%, from 838.8 billion ton miles in 1972 to a peak of 1,245.3 billion ton miles in 1980.

Ton miles in transport then declined slightly and averaged 1,220 billion ton miles from 1981 to 1983. But then, in 1984, transport ton miles dropped rather sharply to 1,180.2 billion ton miles, down 5.2% from the peak. It moved up slightly to 1,195.5 billion ton miles in 1985, due to an increase in crude oil transport. It fell off in 1986 to 1,187.8 billion ton miles as crude production fell. But transport volume rebounded to 1,195.8 billion ton miles in 1987.

Crude oil transported constituted 60.5% of the total in 1980. This was up from 43.2% in 1972. It moved up slightly to 65.8% in 1985, slipped to 63.3% in 1986 and then rose back up to 64.2% in 1987. The sharp increase in crude oil ton miles is due to increased Alaskan production. The shifts in the level of product transport is related to the changing product demand levels.

Movement of crude oil has followed a different pattern from that of overall crude and petroleum products. Transport of crude oil moved up to a peak of 806.1 billion ton miles in 1983. It

dropped to 748.4 billion ton miles in 1984, and then moved up to 786.2 billion ton miles in 1985. It fell to 751.3 billion ton miles in 1986, but then increased to 767.3 billion ton miles in 1987.

For crude oil carried in domestic transport, pipelines and water carriers accounted for 99.7% of total ton miles moved. This has not changed much over the past 15 years. Motor carriers and railroads carry a very small portion of the crude oil moved.

There has been a shift in crude transport from pipelines to water carriers. In 1977, pipelines carried 83.2% of the crude, and water carriers 16.1%. Due to the increased volumes of crude moved long distances by water from Alaska, this shifted to 57.7% pipeline and 41.9% water carrier in 1978. In 1985, this had moved to 42.5% pipeline and 57.2% water carrier. In 1986, it was 55.1% water carrier and 44.6% pipeline. And in 1987, it was 55.2% water carrier and 44.5% pipelines.

The total volume of crude oil carried in transport by pipelines also fell. It was at a peak of 372.2 billion ton miles in 1979. It dropped to 332.4 billion ton miles in 1983. It has been moving up slowly since then. In 1987, it was back up to 341.5 billion ton miles. Water carrier crude oil volume hit a peak of 471.2 billion ton miles in 1983. It fell to 413.6 billion ton miles in 1986. It was up to 423.3 billion ton miles in 1987.

Total ton miles of petroleum products carried in domestic transport peaked in 1978, at 536.7 billion ton miles. That was the year of peak domestic demand. This dropped to 409.3 billion ton miles in 1985, down 23.7%. It then moved back up to 436.5 billion ton miles in 1986, but slipped to 428.5 billion ton miles in 1987. The increase is a reflection of the increased demand, but the pattern of transport volumes is erratic.

Pipelines and water carriers accounted for 90.6% of the product transport in 1987. Motor carriers accounted for 6.7% and railroads 2.6%. Much of the short-haul and smaller volumes are carried by motor carriers. Motor carriers and railroads also service areas where pipelines and water carriers do not or can not provide service.

PIPELINE CONSTRUCTION—1990 AND BEYOND*

Area	†4-10 in.	12-20 in.	22-30 in.	Larger than 30 in.	Total
			Miles		
GAS PIPELINES					
U.S.	560	1,745	6,058	4,642	13,005
Canada	1,331	553	122	4,123	6,129
Latin America	566	138	520	475	1,699
Asia-Pacific	112	765	856	1,295	3,028
Western Europe	590	422	1,510	1,759	4,281
Middle East	—	180	175	880	1,235
Africa	12	18	—	—	30
Total gas	**3,171**	**3,821**	**9,241**	**13,174**	**29,407**
CRUDE PIPELINES					
U.S.	207	157	5	130	499
Canada	35	29	—	—	64
Latin America	87	1,284	282	—	1,653
Asia-Pacific	29	505	250	125	909
Western Europe	25	72	25	106	228
Middle East	—	150	91	—	241
Africa	1,133	510	70	—	1,713
Total crude	**1,516**	**2,707**	**723**	**361**	**5,307**
PROCUCT PIPELINES					
U.S.	775	428	—	—	1,203
Canada	—	—	—	—	—
Latin America	367	322	37	—	726
Asia-Pacific	25	150	841	—	1,016
Western Europe	749	441	—	—	1,190
Middle East	—	—	—	—	—
Africa	499	342	—	—	841
Total product	**2,415**	**1,683**	**878**	—	**4,976**
WORLD TOTALS					
Gas	**3,171**	**3,821**	**9,241**	**13,174**	**29,407**
Crude	**1,516**	**2,707**	**723**	**361**	**5,307**
Product	**2,415**	**1,683**	**878**	—	**4,976**
Total	**7,102**	**8,211**	**10,842**	**13,535**	**39,690**

*Projects planned and under way in 1990 and scheduled for completion beyond 1990. †Includes some projects of less than 4 in. diameter, and excluding eastern Europe and U.S.S.R.

Source: Oil & Gas Journal

Since the peak of transport of petroleum products in 1978, the pipeline volume has decreased slightly and the percentage has moved up considerably. The total pipeline volume was 236.1 billion ton miles in 1979. It dipped to 223.7 billion in 1983 and then bounced back to 235.1 billion in 1984. It moved up to 242.7 billion ton miles in 1986, and 245.3 billion ton miles in 1987. The relative volume increased from 44.2% in 1979 to 56.2% in 1985, 55.6% in 1986, and 57.2% in 1987.

The water carrier volume peaked in 1977 at 270.2 billion ton miles of petroleum products. It fell to 141.2 billion ton miles in 1985. It recovered slightly to 154.5 billion ton miles in 1986. But

TRADE MOVEMENTS

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	% change 89-88	1989 share of total
	(1,000 b/d)												
Imports													
United States	8,410	6,735	5,950	5,040	4,990	5,380	5,065	6,045	6,245	7,240	8,019	+10.8	26.5%
Western Europe	13,080	11,825	10,245	9,350	8,665	8,595	8,365	8,860	7,905	9,104	9,384	+ 3.1	31.0%
Japan	5,605	4,985	4,460	4,155	4,145	4,305	4,045	4,140	4,125	4,412	4,549	+3.1	15.0%
Rest of World	8,255	8,390	8,000	7,020	6,555	6,470	6,645	7,220	6,315	7,111	8,320	+17.0	27.5%
TOTAL WORLD	**35,350**	**31,935**	**28,655**	**25,565**	**24,355**	**24,750**	**24,120**	**26,265**	**24,590**	**27,867**	**30,272**	**+ 8.6**	**100.0%**
Exports													
United States	485	555	605	815	740	720	780	765	745	845	817	– 3.3	2.7%
Canada	455	445	455	485	545	655	685	675	630	890	944	+ 6.1	3.1%
Latin America	3,645	3,885	4,380	4,135	4,065	4,100	3,565	3,600	3,035	3,246	3,511	+ 8.2	11.6%
Middle East	20,435	17,510	14,605	11,660	10,355	9,845	9,340	10,880	10,315	11,842	13,389	+13.1	44.2%
North Africa	3,425	2,820	2,175	2,145	2,180	2,290	2,415	2,515	2,435	2,598	2,415	– 7.0	8.0%
West Africa	2,645	2,475	1,730	1,500	1,425	1,670	1,765	1,980	1,880	2,022	2,319	+14.7	7.7%
Asia*	1,955	1,745	1,700	1,550	1,465	1,655	1,600	1,610	1,410	1,380	1,758	+27.4	5.8%
U.S.S.R., E. Europe & China	1,740	2,005	2,195	2,245	2,655	2,865	2,920	3,020	2,910	3,802	3,478	– 8.5	11.5%
Rest of World	565	495	810	1,030	925	950	1,050	1,220	1,230	1,242	1,641	+32.1	5.4%
TOTAL WORLD	**35,350**	**31,935**	**28,655**	**25,565**	**24,355**	**24,750**	**24,120**	**26,265**	**24,590**	**27,867**	**30,272**	**+ 8.6**	**100.0%**

*Excluding China and Japan
Source: British Petroleum

then it slipped to 143.2 billion ton miles in 1987.

The reduction of the import of residual fuel oil from U.S. Caribbean island refineries was a major factor in this decline. The percentage of products carried by water carriers fell from 50.9% in 1977 to 34.5% in 1985, 34.5% in 1986 and 33.4% in 1987.

Almost all natural gas is transported by pipeline. The changes in the volume of overall domestic production and consumption are major factors determining the transport level of natural gas. The location of production and consumption is also a major factor determining changes in natural gas transport.

The importation of natural gas can also be a factor. Changes in the volume and location of these imports influence decisions concerning pipeline volume and location. Almost all imports are presently from Canada via pipeline. However, there have been some imports of LNG from Algeria and Indonesia.

PIPELINES. Between 1973 and 1982, total U.S. pipeline mileage increased from 419,464 miles to 459,548 miles. This was an increase of 40,084 miles, 9.6%. Gas pipeline mileage increased from 248,773 miles to 286,999 miles, an increase of 38,226 miles. The increase in gas pipelines accounted for 95.4% of the increase in total pipeline mileage. Liquids pipeline mileage was 172,549 miles in 1982, up only 1.1% from 170,691 miles in 1973. Total interstate pipeline mileage in the United States peaked in 1982 at 459,548 miles. That was also the year of peak natural gas pipeline mileage of 286,999 miles, 62.5% of total mileage. Liquids pipeline mileage was 172,549 miles that year.

Total operating mileage fell sharply in 1984. However, it rebounded in 1985 and has oscillated but remained close to 450,000 in 1986, 1987 and 1988. The latest year for which data is available is 1988. In that year, total mileage was 451,838 miles, down 7,710 miles from the peak. Gas pipeline mileage in 1988 was 281,381 miles, down 5,618 miles from the peak. Liquids pipeline mileage was 170,457 miles, down 2,092 miles from 1982. The peak year for liquids pipeline mileage was 1976, with 174,072 miles. Although pipeline mileage is down from the peak in 1982, it was on the rise from 1984 to 1986. It moved up 19,864 miles over the 1984 to 1986 period. In 1987 it slipped again, falling 3,945 miles. But in 1988 it climbed again, increasing 3,888 from 1987.

The change in total mileage does not reflect all new construction. With changes in production and distribution patterns, some old pipelines are shut down each year. Therefore, new construction includes more than just net additions.

So these figures on changes in operating mileage can be a bit misleading with respect to total pipeline construction activity. Even when total mileage was declining, there was ongoing construction activity. New discoveries of crude oil and natural gas and changing distribution patterns for petroleum products and natural gas require an ever-changing pipeline network. Pipelines are added to new or expanding producing areas, and are shut down as areas are depleted. Population growth and movements and changes in the level of economic activity result in new requirements for new distribution pipelines.

CAPITAL SPENDING. The level of expenditures on new pipeline construction activities is quite significant. Pipeline expenditures are a representation of the industry's perception of future long-term needs. Many pipeline projects are of a long duration and do not have an impact on immediate needs. Therefore, the relative level of spending is a good leading indicator of the expected changes in the level of activity in the oil and gas industry.

Industry capital expenditures for transportation requirements are spread over natural gas pipelines, crude oil pipelines, petroleum product pipelines, water transport vessels, railroad cars and motor carriers. However, the vast majority of the spending is for pipeline construction.

Capital spending on total U.S. pipeline construction increased from $672 million in 1972 to $7,390 million in 1982, an increase of 999.7% over the 10 years. Spending on natural gas pipelines increased from $578 million in 1972 to $6,070 million in 1982, 950.2%. Crude and product pipeline outlays in 1982 were $1,320 million, up 1,304.3% from $94 million in 1972. Outlays for crude and product pipelines have been more volatile, reaching a peak of $2,949 million in 1976 when the Alaskan pipeline was under construction. After that project, the highest level of spending was reached in 1983 at $2,456 million.

Pipeline spending fell following the downturn in demand and the drop in prices. Spending on crude oil pipelines, petroleum product pipelines and natural gas pipelines all dropped sharply. Total pipeline spending fell to $1,744 million in 1986, down 76.4% from 1982. Of the 1986 total, $1,309 million was for natural gas pipelines and $435 million for crude and products pipelines. Natural gas pipeline spending was down 78.4% from the 1982 level.

There was a shift in the trend in 1987. Total pipeline spending moved up to $2,289 million. Natural gas pipeline spending increased to $1,556 million, and crude and product pipeline spending moved up to $733 million. Outlays slipped a bit in 1988 to $2,059 million. Natural gas pipeline spending moved up to $1,659 million, and crude and product pipeline spending fell to $400 million. But total spending slipped again in 1989, falling to $1,420 million for total pipeline construction. Natural gas pipeline capital expenditures fell to only $969 million. Crude and product pipeline construction moved up slightly to $451 million.

Plans for 1990 outlays show a sharp increase to $2,538 million, due mainly to a sharp increase in natural gas pipeline outlays. Spending on those pipelines will increase to $2,033 million. Capital spending on crude oil and product pipelines will be up also, increasing to $505 million.

Ocean-going tankers for the transportation of crude also represent huge investments. But

WORLD LIQUID GAS CARRIER FLEET BY SIZE AND TYPE — 1988

(As at year end — in Th.Cubic Metres)

Size group	LPG		LNG		Total	
	No.	Capacity	No.	Capacity	No.	Capacity
Up to/ 999	104	71.6	—	—	104	71.6
1,000/ 1,999	200	277.2	1	1.1	201	278.3
2,000/ 4,999	135	402.8	6	16.5	141	419.3
5,000/ 9,999	72	478.3	1	5.0	73	483.3
10,000/19,999	49	669.2	—	—	49	669.2
20,000/39,999	26	713.7	5	157.4	31	871.1
40,000/59,999	22	1,166.1	6	252.2	28	1,418.3
60,000/99,999	53	4,027.4	11	848.9	64	4,876.3
100,000 & over	1	101.0	42	5,334.9	43	5,435.9
TOTAL WORLD	**662**	**7,907.3**	**72**	**6,616.0**	**734**	**14,523.3**

Note: Figures are individually rounded.

Source: OPEC Statistical Bulletin

during the period of a declining market, with substantially reduced demand, and therefore reduced import/export volumes, there was a massive surplus of tanker tonnage. The domestic industry also uses water carriers for a substantial part of crude oil and product transport. With reduced domestic demand, transport volumes dropped, reducing the need for additional investment in tankers.

Investment for other land transport and inland water transport represents smaller outlays and is less volatile. A reduction in expenditures due to lower demand levels was offset somewhat by increased expenditures due to changing patterns of distribution.

When demand was rising, capital expenditures on other modes of transport also moved up rapidly, increasing from $175 million in 1972 to $895 million in 1981, up 411.4%. When demand started to decline, outlays also started to fall. Investment in this sector dropped to $310 million in 1987. This was a decline of 65.4%. Investment rebounded in 1988 to $416 million, then moved up to $498 million in 1990. Plans for 1990 are for industry outlays of $699 million, up 125.5% from 1987. This is related to the rapid increase in demand for petroleum products and the increase in imports.

TANKERS. A large portion of the outlays for other transport are for ocean-going tankers for crude transport. And spending for these tankers moves with the level of worldwide crude and product import/export trade.

When imports fell sharply, this had a negative impact on the tanker industry. The worldwide tanker industry was severely depressed due to the sharp drop in trade, as demand fell following the crude price hike.

The tanker fleet fell from a peak of 332.5 million deadweight tons in 1977 to 239.4 million tons in 1987. This was a drop of 28%. And much of the existing tonnage was idle or under-utilized. However, the reduction seemed to hit bottom in 1987. The small size of the fleet reduction in 1987, only 1.6 million deadweight tons, was an indication that the size of the tanker fleet was in better balance with demand.

The adjustment took the shape of eliminating redundant VLCC tankers. These are used mainly for long-distance transport, and the long haul volumes of crude from the Persian Gulf to the United States were cut sharply with the drop in imports. The industry is now concentrating on smaller and more flexible tankers. To hold down losses, many excess tankers were converted for other uses, such as offshore storage.

The development of the North Sea oil fields also had a substantial impact on the tanker industry. As these fields developed, Europe was transformed from long haul tanker trade to short-haul. In the early and mid-1970s, Europe relied primarily on long-haul oil from the Persian Gulf. This oil moved in VLCC tankers through the Straits of Hormuz and around the Cape of Good Hope. With the development of the North Sea fields, many of these tankers were no longer needed.

With increased worldwide demand and increased petroleum import/export trade, the tanker fleet began to move back up in 1988 and 1989. The fleet moved up to 243.5 million dwt at year end 1988 and to 249.9 million dwt at year end 1989. This is an indication that the picture is changing for the tanker fleet. Petroleum demand and imports are increasing worldwide. The increased import requirements are most dramatic for the U.S.. And the U.S. import requirements appear to be the real key to the change in tanker needs.

Worldwide trade of oil fell off sharply from a peak of 35.35 million b/d in 1979 to a low of 24.12 million b/d in 1985. This was a decline of 31.8%, a drop of 11.23 million b/d in world trade volumes. But this has also been rebounding since the decline in prices and the increase in petroleum product demand. The worldwide trade volume moved up to 26.265 million b/d in 1986 on the strength of increased demand and increased U.S.

imports. It fell to 24.59 million b/d in 1987 when prices rebounded and trade slowed. With reduced prices in 1988, the trade volume jumped to 27.867 million b/d. It continued up to 30.272 million b/d in 1989. It increased 5.682 million b/d over two years. A good portion of this is the increase in U.S. imports.

OUTLOOK

The conflict in the Middle East has resulted in much higher worldwide crude oil prices. The sharp reduction in worldwide crude oil supply pushed up the average price of world export crude oils 50% in the three weeks following the invasion. This has taken a large volume, 4.2–4.5 million b/d, out of world trade movements. The fear of the outbreak of hostilities has also substantially raised the cost of tanker transport, contributing further to the cost of imported oil.

The substantially higher prices will tend to lead to reduced demand and therefore possibly a further reduction in tanker volumes. A reduction in demand could also have an effect on domestic U.S. distribution patterns. With much higher crude oil prices there will also be an increase in fuel switching. In the United States this could mean an increase in natural gas demand. With an increase in natural gas demand, additional pipeline capacity will be required.

At this time it is uncertain how long the crisis involving Iraq and Kuwait will last. It is quite probable that the loss of this volume of crude oil will exert upward pressure on crude oil prices as long as the crisis continues. This makes it almost impossible to project with any certainty the most likely trend in investments over the forecast period.

Therefore, in this edition of the Oil Industry Outlook, three scenarios are being presented. The three scenarios vary in expectations of the length of time the crisis in the Persian Gulf will last. The length of time the oil crisis continues will determine the trend in the price of crude oil and therefore the trend in tanker transport, product demand, energy demand and transport investment. To cover these variations three separate forecasts are presented. The forecast with the highest degree of probability is the one that comes closest to estimating the length of time it takes to finally resolve this issue in the Middle East, and for Iraqi and Kuwaiti oil to return to the market. Following is a brief review of the key points of each scenario. They are discussed in more detail in earlier chapters.

Scenario I—The embargo of oil exported from Iraq and Kuwait continues for a period of 6–18 months. The vast majority of oil production in Iraq and Kuwait is shut in for the duration of the dispute. Oil production capacity in other OPEC areas is not affected by the dispute. Following the settlement of the dispute, production in Iraq and Kuwait is resumed at previous levels.

Scenario II—The embargo of oil exported from Iraq and Kuwait continues for a period of 18–30 months. The vast majority of oil production in Iraq and Kuwait is shut in for the extended duration of the dispute. Oil production capacity in other OPEC areas is not affected by the dispute. Following the settlement of the dispute, production in Iraq and Kuwait is resumed at previous levels.

Scenario III—The embargo of oil exported from Iraq and Kuwait continues for less than six months. The vast majority of oil production in Iraq and Kuwait is shut in during this period. Production capacity in other OPEC countries is not affected by this dispute. Following settlement of the dispute, production in Iraq and Kuwait is resumed at previous levels.

The major differences between the three scenarios is the length of time that the crisis continues and Iraqi and Kuwaiti oil is off the market. But even though the length of time until settlement of the dispute is the only apparent difference, these three scenarios will cause three

distinct sets of conditions in the oil market. And the different market conditions will create differing projections of price, economic growth, demand, transport and investment over the forecast period, 1991–95.

A continued increase in economic activity will boost the demand for energy and for natural gas and petroleum products. But the consuming areas are not generally the areas with the huge reserves and production. Therefore, increasing volumes of crude oil, natural gas and petroleum products will require transport of some type.

SCENARIO I—Crude oil prices will remain at an elevated level throughout 1991. This will slow economic growth and energy demand worldwide and in the U.S. It will also slow the growth in demand for petroleum products worldwide and in the United States. Worldwide demand is projected to move up 681,000 b/d in 1991. U.S. demand will move up 100,000 b/d. U.S. imports are projected to increase 235,000 b/d, to 8.595 million b/d. Worldwide petroleum trade will increase 914,000 b/d. Increased U.S. imports will account for 25.7% of the increase in worldwide trade.

In 1992, after settlement of the dispute, prices will fall sharply. This will give a boost to economic growth and energy consumption. Prices will move up over the remainder of the forecast period, but not fast enough to dampen economic, energy, and product demand growth. Worldwide demand will move up to 70.329 million b/d in 1995. This is an increase of 4.59 million b/d over the forecast period. U.S. demand will move up to 18.37 million b/d in 1995, an increase of 1.18 million b/d. U.S. imports will increase to 10.075 million b/d in 1995, an increase of 1.715 million b/d from the level in 1990. The volume of petroleum in world trade will increase 20%, to 37.880 million b/d, up 6.304 million b/d from 1990. The increase in U.S. imports will account for 27.2% of the increase.

The increase in economic activity over the forecast period will result in increased energy consumption. One of the major sources of energy that is expected to grow substantially over the forecast period is natural gas. Natural gas consumption will be on the increase worldwide, and U.S. domestic demand will be rising. U.S. consumption of natural gas is projected to be up 9.5% in 1995, an increase of 1,765 bcf. Domestic production is projected to be up 8.4%, an increase of 1,515 bcf, and imports are projected to be up 21.9%, an increase of 340 bcf.

A substantial part of the increase in consumption of petroleum products will take place in the industrial countries. Many of these countries have either low or declining rates of domestic production. There will also be substantial increases in demand in developing countries that have low levels of oil production. These needs can only be met by imported crude oil or petroleum products. Therefore, worldwide import/export petroleum trade will move up much faster than demand. The increase in U.S. imports will be a major part of the increase in trade. And because of the distance required to bring imports to the U.S., it will account for a much larger proportion of the increased transport requirement.

This large increase in crude oil and petroleum product trade will require additional transport. There will be a substantial increase in requirements for ocean going vessels to handle the increased import/export trade. There will also be increased requirements for surface transport to move crude and products, due to the increase in product consumption. And finally, there will be a significant increase in demand for pipeline capacity. Additional pipelines will be required to move crude oil, petroleum products and natural gas.

These increased volumes will require additional investment in transport over the forecast period. A lot of that investment will be in new pipeline construction.

Total U.S. capital expenditures for new pipeline construction are expected to increase 23.5% over the forecast period, to $3,135 million in 1995. This is an increase of $597 million in the level of annual spending. Outlays for natural gas pipelines will increase 25.2%, up $512 million to $2,545 million in 1995. Crude and product pipeline construction will increase 16.8%, up $85 million to $590 million in 1995. Increased exploration and drilling activity, increased demand for petroleum products, and increased imports will all have an impact on supply patterns and therefore on the level of pipeline construction.

U.S. capital expenditures for other transport needed by the industry will also be affected by increased activity and demand. Increased demand will call for increased transport of products to areas of consumption. Increased worldwide trade will call for additional ocean going tankers. Capital spending for other transport will move up 83.8%, to $1,285 million in 1995. This is an increase of $586 million in the level of annual investment.

SCENARIO II—Crude oil prices will remain at an elevated level throughout 1991 and 1992. This will slow economic growth and energy demand worldwide and in the U.S. It will also slow the growth in demand for petroleum products worldwide and in the United States. Worldwide demand is projected to move up 681,000 b/d in 1991. U.S. demand will move up 100,000 b/d. U.S. imports are projected to increase 235,000 b/d, to 8.595 million b/d. Worldwide petroleum trade will increase 914,000 b/d. Increased U.S. imports will account for 25.7% of the increase in worldwide trade.

Worldwide demand will move up an additional 751,000 b/d in 1992. U.S. demand will increase 120,000 b/d. Falling U.S. production and increased demand will result in U.S. imports moving up 215,000 b/d, to 8.81 million b/d. Worldwide petroleum trade will increase 970,000 b/d. U.S. imports will account for 22.2% of the increase in world trade.

In 1993, after settlement of the dispute, prices will fall sharply. This will give a boost to economic growth and energy consumption. Prices will move up over the remainder of the forecast period, but not fast enough to dampen economic, energy, and product demand growth. Worldwide demand will move up to 70.147 million b/d in 1995. This is an increase of 4.408 million b/d over the forecast period. U.S. demand will move up to 18.21 million b/d, an increase of 1.02 million b/d. U.S. imports will increase to 9.86 million b/d in 1995, an increase of 1.5 million b/d from the level in 1990. The volume of petroleum in world trade will increase 18.7%, to 37.485 million b/d, up 5.909 million b/d from 1990. The increase in U.S. imports will account for 25.4% of the increase.

The increase in economic activity over the forecast period will result in increased energy consumption. One of the major sources of energy that is expected to grow substantially over the forecast period is natural gas. Natural gas consumption will be on the increase worldwide, and U.S. domestic demand will be rising. U.S. consumption of natural gas is projected to be up 5.2% in 1995, an increase of 970 bcf. Domestic production is projected to be up 3.9%, an increase of 715 bcf, and imports are projected to be up 19.4%, an increase of 300 bcf.

A substantial part of the increase in consumption of petroleum products will take place in the industrial countries. Many of these countries have either low or declining rates of domestic production. There will also be substantial increases in demand in developing countries that have low levels of oil production. These needs can only be met by imported crude oil or petroleum products. Therefore, worldwide import/export petroleum trade will move up much faster than demand. The increase in U.S. imports will be a major part of the increase in trade. And because of the distance required to

bring imports to the U.S., it will account for a much larger proportion of the increased transport requirement.

This large increase in crude oil and petroleum product trade will require additional transport. There will be a substantial increase in requirements for ocean-going vessels to handle the increased import/export trade. There will also be increased requirements for surface transport to move crude and products, due to the increase in product consumption. And finally, there will be a significant increase in demand for pipeline capacity. Additional pipelines will be required to move crude oil, petroleum products and natural gas.

These increased volumes will require additional investment in transport over the forecast period. A lot of that investment will be in new pipeline construction.

Total U.S. capital expenditures for new pipeline construction are expected to increase 21.9% over the forecast period, to $3,095 million in 1995. This is an increase of $557 million in the level of annual spending. Outlays for natural gas pipelines will increase 23.7%, up $482 million to $2,515 million in 1995. Crude and product pipeline construction will increase 14.9%, up $75 million to $580 million in 1995. Increased exploration and drilling activity, increased demand for petroleum products, and increased imports will all have an impact on supply patterns and therefore on the level of pipeline construction.

U.S. capital expenditures for other transport needed by the industry will also be affected by increased activity and demand. Increased demand will call for increased transport of products to areas of consumption. Increased worldwide trade will call for additional ocean-going tankers. Capital spending for other transport will move up 81.7%, to $1,270 million in 1995. This is an increase of $571 million in the level of annual investment.

SCENARIO III—Crude oil prices will remain at an elevated level only through 1990 and possibly into early 1991. This will slow economic growth, energy demand and product demand for only a short period of time.

After settlement of the dispute in 1991, prices will fall sharply. This will give a boost to economic growth and energy consumption. Prices will move up gradually over the forecast period, and not fast enough to dampen economic, energy, and product demand growth. Worldwide demand will move up to 71.568 million b/d in 1995. This is an increase of 5.465 million b/d over the forecast period. U.S. demand will move up to 18.645 million b/d, an increase of 1.355 million b/d. U.S. imports will increase to 10.440 million b/d in 1995, an increase of 1.835 million b/d from the level in 1990. The volume of petroleum in world trade will increase 22.7% to 39.485 million b/d, up 7.3 million b/d from 1990. The increase in U.S. imports will account for 25.1% of the increase.

The increase in economic activity over the forecast period will result in increased energy consumption. One of the major sources of energy that is expected to grow substantially over the forecast period is natural gas. Natural gas consumption will be on the increase worldwide, and U.S. domestic demand will be rising. U.S. consumption of natural gas is projected to be up 13.3% in 1995, an increase of 2,470 bcf. Domestic production is projected to be up 12.3%, an increase of 2,230 bcf, and imports are projected to be up 23.9%, an increase of 370 bcf.

A substantial part of the increase in consumption of petroleum products will take place in the industrial countries. Many of these countries have either low or declining rates of domestic production. There will also be substantial increases in demand in developing countries that have low levels of oil production. These needs can only be met by imported crude oil or petroleum products. Therefore, worldwide import/export petroleum trade will move up

much faster than demand. The increase in U.S. imports will be a major part of the increase in trade. And because of the distance required to bring imports to the U.S., it will account for a much larger proportion of the increased transport requirement.

This large increase in crude oil and petroleum product trade will require additional transport. There will be a substantial increase in requirements for ocean going vessels to handle the increased import/export trade. There will also be increased requirements for surface transport to move crude and products, due to the increase in product consumption. And finally, there will be a significant increase in demand for pipeline capacity. Additional pipelines will be required to move crude oil, petroleum products and natural gas.

These increased volumes will require additional investment in transport over the forecast period. A lot of that investment will be in new pipeline construction.

Total U.S. capital expenditures for new pipeline construction are expected to increase 27.7% over the forecast period, to $3,170 million in 1995. This is an increase of $688 million in the level of annual spending. Outlays for natural gas pipelines will increase 29.7%, up $588 million to $2,570 million in 1995. Crude and product pipeline construction will increase 20%, up $100 million to $600 million in 1995. Increased exploration and drilling activity, increased demand for petroleum products, and increased imports will all have an impact on supply patterns and therefore on the level of pipeline construction.

U.S. capital expenditures for other transport needed by the industry will also be affected by increased activity and demand. Increased demand will call for increased transport of products to areas of consumption. Increased worldwide trade will call for additional ocean going tankers. Capital spending for other transport will move up 90.9%, to $1,300 million in 1995. This is an increase of $619 million in the level of annual investment. U.S. pipeline construction activity and investment may not return to the boom levels of 1981–83, but it is obvious that a substantial level of new construction is planned. The pipeline industry has been required to change substantially to adjust to changing expectations for the industry and changing requirements for pipeline transport. They will be required to adjust again. Demand for natural gas and crude oil are expected to increase during the forecast period, and that will require additional pipelines.

The latest survey of pipeline construction plans listed plans for an additional 39,690 miles of pipeline to be constructed in the non-communist world in 1990 and the years after. A total of 14,707 miles is planned for the United States and 24,983 miles outside the United States. This recent survey shows 37.1% of the pipeline construction planned for the United States. In 1987 this survey showed 69.8% of the construction planned for the United States. This is an indication of the industry shift to non-U.S. production activities.

The growing worldwide importance of the natural gas industry is reflected in the 29,407 miles of new gas pipeline planned. Of this total, 13,005 miles is planned for the United States and 16,402 miles outside the United States. Canadian plans are for an additional 6,129 miles. Much of this is to supply export gas for the U.S. market. Western Europe plans call for construction of 4,281 miles. In the Asia-Pacific countries, 3,026 miles have been planned. Substantial mileage is planned for all of the other areas except Africa: Latin America, 1,699 miles of gas pipeline; Middle East, 1,235 miles; and Africa, 30 miles.

A total of 5,307 miles of new crude pipeline is planned, with 499 miles in the U.S. and 4,808 miles of crude oil pipeline outside the U.S. There are 1,653 miles planned for Latin America, and 1,713 miles in Africa. This is fol-

lowed by Asia-Pacific with 909 miles; Middle East, 241 miles; Western Europe, 228 miles; and Canada, 64 miles.

Total product pipeline mileage planned to be constructed is 4,976 miles, with 1,203 miles in the U.S. and 3,773 miles outside the U.S. Plans call for 1,190 miles in Western Europe and 1,016 miles in Asia-Pacific. Africa has 841 miles planned and Latin America 726 miles.

The United States leads the way in construction plans for natural gas and products pipelines, but Africa leads for crude pipelines. Total U.S. pipeline miles planned is 14,707 miles. Plans are for 6,193 miles in Canada, almost all gas pipeline. Much of this is for export to the U.S. market. Plans for Western Europe call for 5,699 miles of pipeline. Asia-Pacific plans are for 4,953 miles. In Latin America, it's 4,078 miles; in Africa, 2,581 miles; and in the Middle East, 1,476 miles of pipeline are planned.

All of these changes and additions are reflected in the projected increase in transport capital expenditures over the 1990–95 period.

TRANSPORTATION KEYS TO THE FUTURE SCENARIO I

1. U.S. and worldwide demand for petroleum products, crude oil and natural gas will increase over the forecast period. However, prices will remain elevated through 1991, due to the upheaval in the Middle East. The higher prices will slow demand growth in 1991. But demand growth will accelerate in 1992 when prices fall.

2. The increased demand will result in a substantial increase in the worldwide petroleum import/export trade. Declining U.S. crude production will increase the volume that must be supplied via worldwide import/export trade. Growth in trade will be slowed in 1991, due to the higher prices. The elevated prices will slow demand and stimulate production in the U.S. and possibly some other importing countries. However, when the prices fall in 1992, import/export trade will grow more rapidly. This will continue to move up over the remainder of the forecast period.

3. Transport requirements in the U.S. will change markedly during the forecast period. U.S. demand for petroleum products and natural gas will move up over the 1991–95 forecast period. This will increase the volume in transport. Growth in demand for petroleum products and demand for natural gas will slow in 1991. However, growth in demand for both will grow more rapidly in 1992 after prices fall.

4. All of these increases in consumption, production and trade will boost requirements for all types of transport: tankers, pipelines, and motor and rail transport.

5. The increased transport requirements will result in increased capital spending on transport facilities and equipment throughout the forecast period. Annual U.S. outlays will move up throughout the forecast period. The level of investment will be related to anticipated future demand and the level of available industry funds. However, the funds have to be committed before the demand exists. Most of the expenditures will go for natural gas pipelines. Total spending for transport in 1995 will be up 36.5% from the 1990 level.

THE OUTLOOK — TRANSPORTATION
SCENARIO — I

	1989	1990	1991	1992	1993	1994	1995	Change 1990 to 1995	% change 1990 to 1995
CAPITAL SPENDING - U.S.									
(Million $)									
Natural gas pipelines	969	2,033	2,265	2,360	2,435	2,475	2,545	+512	+25.2
Crude and product pipelines	451	505	575	540	560	580	590	+85	+16.8
Other transport	498	699	865	970	1,085	1,135	1,285	+586	+83.8
Total transportation	**1,918**	**3,237**	**3,705**	**3,870**	**4,080**	**4,240**	**4,420**	**+1,183**	**+36.5**
WORLD PETROLEUM TRADE									
(thousand barrels/day)	30,272	31,576	33,490	33,920	35,365	36,630	37,880	+6,304	+20.0
TOTAL U.S. CRUDE IMPORTS									
Industry and SPR crude									
(thousand barrels/day)	5,843	6,070	6,295	6,780	7,185	7,465	7,710	+1,640	+27.0
U.S. PRODUCT IMPORTS									
(thousand barrels/day)	2,217	2,290	2,300	2,315	2,330	2,350	2,365	+75	+3.3

TRANSPORTATION KEYS TO THE FUTURE SCENARIO II

1. U.S. and worldwide demand for petroleum products, crude oil and natural gas will increase over the forecast period. Prices will remain elevated through 1991 and 1992, due to the upheaval in the Middle East. The higher prices will slow demand growth in 1991 and in 1992. However, demand growth will accelerate in 1992 when prices fall following the settlement of the dispute.

2. The increased demand will result in a substantial increase in the worldwide petroleum import/export trade. Declining U.S. crude production will increase the volume that must be supplied via worldwide import/export trade. Growth in trade will be slowed in 1991 and 1992, due to the higher prices. The elevated prices will slow demand and stimulate production in the United States and possibly some other importing countries. However, when the prices fall in 1993, import/export trade will grow more rapidly. This will continue to move up over the remainder of the forecast period. Total trade volumes will be lower than under Scenario I and Scenario III.

3. Transport requirements in the United States will change markedly during the forecast period. U.S. demand for petroleum products and natural gas will move up over the 1991–95 forecast period. This will increase the volume in transport. Growth in demand for petroleum products and demand for natural gas will slow in 1991 and 1992. However, growth in demand for both will grow more rapidly in 1993 after prices fall.

4. All of these increases in consumption, production and trade will boost requirements for all types of transport: tankers, pipelines, and motor and rail transport.

5. The increased transport requirements will result in increased capital spending on transport facilities and equipment throughout the forecast period. Annual U.S. outlays will move up throughout the forecast period. The level of investment will be related to anticipated future demand and the level of available industry funds. However, the funds have to be committed before the demand exists. Most of the expenditures will go for natural gas pipelines. Total spending for transport in 1995 will be up 34.8% from the 1990 level. The growth in spending will be slightly lower than under Scenario I and Scenario III.

THE OUTLOOK — TRANSPORTATION
SCENARIO — II

	1989	1990	1991	1992	1993	1994	1995	Change 1990 to 1995	% change 1990 to 1995
CAPITAL SPENDING - U.S.									
(Million $)									
Natural gas pipelines	969	2,033	2,265	2,515	2,335	2,410	2,515	+482	+23.7
Crude and product pipelines	451	505	575	610	550	570	580	+75	+14.9
Other transport	498	699	865	1,050	1,050	1,160	1,270	+571	+81.7
Total transportation	**1,918**	**3,237**	**3,705**	**4,175**	**3,935**	**4,140**	**4,365**	**+1,128**	**+34.8**
WORLD PETROLEUM TRADE									
(thousand barrels/day)	30,272	31,576	32,490	33,460	34,885	36,205	37,485	+5,909	+18.7
TOTAL U.S. CRUDE IMPORTS									
Industry and SPR crude									
(thousand barrels/day)	5,843	6,070	6,295	6,505	6,935	7,250	7,515	+1,445	+23.8
U.S. PRODUCT IMPORTS									
(thousand barrels/day)	2,217	2,290	2,300	2,305	2,310	2,325	2,345	+55	+ 2.4

TRANSPORTATION KEYS TO THE FUTURE SCENARIO III

1. U.S. and worldwide demand for petroleum products, crude oil and natural gas will increase over the forecast period. Prices will remain elevated only through the remainder of 1990 and possibly early 1991, due to the upheaval in the Middle East. The higher prices will slow demand growth only marginally in 1991. Demand growth will accelerate in 1992 and continue up over the remainder of the forecast period.

2. The increased demand will result in a substantial increase in the worldwide petroleum import/export trade. Declining U.S. crude production will increase the volume that must be supplied via worldwide import/export trade. Growth in trade will be slowed only briefly due to the higher prices. Import/export trade will continue to move up over the remainder of the forecast period. Trade will grow more than under the first two scenarios.

3. Transport requirements in the United States will change markedly during the forecast period. U.S. demand for petroleum products and natural gas will move up over the 1991–95 forecast period. This will increase the volume in transport. Growth in demand for petroleum products and demand for natural gas will move up over the forecast period and put pressure on transport requirements.

4. All of these increases in consumption, production and trade will boost requirements for all types of transport: tankers, pipelines, and motor and rail transport.

5. The increased transport requirements will result in increased capital spending on transport facilities and equipment throughout the forecast period. Annual U.S. outlays will move up throughout the forecast period. The level of investment will be related to anticipated future demand and the level of available industry funds. However, the funds have to be committed before the demand exists. Most of the expenditures will go for natural gas pipelines. Total spending for transport in 1995 will be up 41.3% from the 1990 level. Spending will be highest under this scenario.

THE OUTLOOK — TRANSPORTATION
SCENARIO — III

	1989	1990	1991	1992	1993	1994	1995	Change 1990 to 1995	% change 1990 to 1995
CAPITAL SPENDING - U.S.									
(Million $)									
Natural gas pipelines	969	1,982	2,215	2,420	2,460	2,510	2,570	+588	+29.7
Crude and product pipelines	451	500	525	550	570	590	600	+100	+20.0
Other transport	498	681	800	1,000	1,100	1,200	1,300	+619	+90.9
Total transportation	**1,918**	**3,163**	**3,540**	**3,970**	**4,130**	**4,300**	**4,470**	**+1,307**	**+41.3**
WORLD PETROLEUM TRADE									
(thousand barrels/day)	30,272	32,185	33,565	35,405	36,795	38,170	39,485	+7,300	+22.7
TOTAL U.S. CRUDE IMPORTS									
Industry and SPR crude									
(thousand barrels/day)	5,843	6,305	6,605	7,105	7,460	7,760	8,040	+1,735	+27.5
U.S. PRODUCT IMPORTS									
(thousand barrels/day)	2,217	2,300	2,330	2,345	2,360	2,380	2,400	+100	+ 4.3

NATURAL GAS

Over the past few years there has been a great deal of optimism expressed about the future of the worldwide and U.S. natural gas industries. That optimism is based upon the future need for an abundant, efficient, clean burning, non-polluting fuel to power future economic growth in the U.S. and elsewhere.

The recent upheaval will probably not affect the long-range view of the expected growth in the natural gas industry. However, it

UNITED STATES NATURAL GAS SUPPLY AND DEMAND

	1975	1980	1984	1986	1988	1989
			Billion cu ft			
Marketed production	20,109	20,180	18,230	16,791	17,808	17,955
Supplemental gas	0	155	110	113	101	157
Imports	953	985	843	750	1,294	1,378
Losses (including extraction)	(1,107)	(1,417)	(980)	(1,227)	(1,160)	(962)
Total supply	**19,955**	**19,903**	**18,203**	**16,427**	**16,843**	**18,528**
Exports	73	49	55	61	74	70
Stock change	344	(23)	(197)	145	58	354
Domestic demand	**19,538**	**19,877**	**17,951**	**16,221**	**16,711**	**18,104**
			Sector demand (Trillion BTU)			
Residential & commercial	7,581	7,540	7,291	6,824	7,512	7,661
Industrial	8,532	8,394	7,449	6,693	7,693	8,265
Transportation	595	650	545	499	632	584
Electric utility	3,240	3,810	3,220	2,691	2,709	2,845
Total	**19,948**	**20,394**	**18,505**	**16,707**	**18,546**	**19,355**

Source: Energy Information Administration

will have an impact on the shorter-range growth patterns in this industry. The loss to the world oil market of crude oil from Iraq and Kuwait has driven up the price of crude oil to the highest levels since 1985. And prices may go even higher during the winter peak demand periods. The higher prices will have several effects on the economy and energy markets that might affect natural gas.

The higher oil prices will probably cause some fuel switching away from oil products and to natural gas. However, the higher energy costs may slow economic growth and overall energy demand. And that might reduce the demand for natural gas. The length of time that the Iraqi and Kuwaiti crude is off the market and the prices are elevated will help determine the future trend in the natural gas industry.

Activity in the upstream sector of the U.S. natural gas industry was somewhat depressed for a period of time due to low gas prices and demand. However, a turning point may have been reached. Consumption of natural gas has been moving up in recent years and this has stimulated some new exploration activity in the natural gas industry. It now appears that the industry could be poised for a period of sustained growth.

The U.S. natural gas industry lagged behind other sectors of the overall energy industry in adjusting to the volatile price changes of the late 1970s and 1980s. The slow adjustment to the price swings had an adverse impact on the natural gas industry. Natural gas lost market share in the energy business to competing fuels, and this resulted in a drop in consumption of natural gas.

Prices and demand for energy have exhibited a great deal of volatility over the recent past. And structural changes, such as multi-fuel capacity and conservation programs, have increased the level of competition in the energy business. Faced with the substantial volatility and increased competition, it is necessary to be able to adjust rapidly to changing conditions, in order to retain market share.

There are two major problem areas that have confronted the natural gas industry and made the adjustment process more difficult. First, there are the myriad of government regulations and controls to contend with. Second, there is the structure of the industry and the changing relationship between producers, pipeline companies and consumers.

Government regulation of the natural gas industry has been a major impediment to its ability to adjust to changing conditions and compete effectively. Government controls and regulations tend to distort the economics and interfere with the market mechanism. Government price controls have not allowed the market the self-correcting

mechanism that would enable rapid movement to demand and supply equilibrium at a market-clearing price.

The long-term contractual arrangements that were, in the past, an integral part of the industry trading operation also proved to be a problem area when rapid price adjustment was required. Resolving this problem had prevented the industry from concentrating resources and energy on resolving other problems facing the industry.

In addition the natural gas industry has had to contend with the "gas bubble." The gas bubble is the natural gas industry's large excess gas deliverability. It is comparable to OPEC's excess capacity and it also puts downward pressure on prices. The gas bubble developed because demand fell sharply due to higher prices, and the industry was not able to adjust rapidly to the change.

There are signs that many of these problems are being resolved, and this will help to restore growth to the industry. Some experts believe the gas bubble has already disappeared. That would be a major boost to gas prices.

But natural gas now finds itself in a very competitive energy market. In order to retain markets, the natural gas industry will have to be aggressive in marketing and flexible in pricing. Prices will have to be adjusted quickly to meet the competition from other fuels and changing seasonal demand patterns. One thing that could help greatly would be the elimination of confusing and inefficient government controls. Returning natural gas to a more market-oriented structure would lead quickly to a stronger, more efficient industry.

REVIEW

GAS DELIVERABILITY. The substantial increase in energy and natural gas prices in the first half of this decade had a major unsettling impact on the natural gas industry. Prior to the jump in prices, demand for natural gas moved up or down with movements in the level of economic activity. Natural gas was priced so that it held an advantage over competing fuels in certain key sectors of the economy and/or areas of the country. This enabled natural gas to maintain a base demand load, while the industry attempted to expand into other areas and markets.

Natural gas prices followed other energy prices and moved up slowly in the early 1970s. As other energy prices moved up at an accelerated pace, natural gas prices trailed but followed the same upward path. On the supply side, higher natural gas prices stimulated exploration and drilling for natural gas. And as a result, natural gas deliverability increased. At the same time, on the demand side, higher prices led to conservation and increased competition from competing fuels. And demand for natural gas moved lower.

Although other energy prices such as crude oil started falling in 1981, natural gas prices continued to move up until 1984. At higher prices, natural gas faced even greater competition. The price advantage that natural gas held in certain sectors was diminished. Natural gas lost some base load to conservation and still more to other fuels.

These changes in the market resulted in the development of a substantial "gas bubble,"

NATURAL GAS PROCESSING AND LIQUIDS PRODUCTION

	Billion cu ft			Natural gas liquids	
	Gross gas production	Gas processed	Percent processed	Gallons per Mcf of gas processed	Liquids produced (000 b/d)
1970	23,786	18,509	77.8	1.376	1,661
1971	24,088	19,252	79.9	1.348	1,693
1972	24,016	19,906	82.9	1.347	1,744
1973	24,067	19,679	81.8	1.353	1,737
1974	22,850	18,684	81.8	1.386	1,689
1975	21,104	17,748	84.1	1.410	1,632
1976	20,944	17,718	84.6	1.388	1,604
1977	21,097	17,570	83.2	1.400	1,618
1978	21,309	17,012	79.8	1.381	1,567
1979	21,883	16,400	75.0	1.481	1,585
1980	21,870	15,750	72.0	1.537	1,576
1981	21,587	14,817	68.6	1.664	1,609
1982	20,210	14,164	70.1	1.678	1,550
1983	18,597	13,173	70.8	1.814	1,559
1984	20,192	13,946	69.1	1.792	1,630
1985	19,534	14,145	72.4	1.744	1,609
1986	19,063	13,985	73.4	1.700	1,551
1987	20,056	15,073	76.1	1.622	1,595
1988	20,880	15,274	73.2	1.631	1,625
1989	20,937	15,606	74.5	1.519	1,546

Source: Oil & Gas Journal and Energy Information Administration.

U.S. GAS PRODUCTION AND RESERVES

	1973	1977	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	% change 89/73
	(Billion cu ft)													
Marketed production:														
Texas	8,514	7,051	7,175	7,116	6,910	6,469	5,939	6,185	6,053	6,152	6,126	6,286	6,211	−27.0
Louisiana	8,242	7,215	7,266	6,940	6,780	6,172	5,332	5,825	5,013	4,895	5,123	5,180	5,139	−37.6
Others	5,891	5,759	6,030	6,124	6,266	5,879	5,551	6,220	6,132	5,744	6,100	6,342	6,605	+12.1
Total U.S.	**22,648**	**20,025**	**20,471**	**20,180**	**19,956**	**18,520**	**16,822**	**18,230**	**17,198**	**16,791**	**17,349**	**17,808**	**17,955**	**−20.7**
	(Billion cu ft)													
Reserves:														
Total U.S.	249,950	208,878	194,917	199,021	201,730	201,512	200,247	197,463	193,369	191,586	187,211	168,024	167,116	−33.1
	(Years)													
Reserves/production ratio:														
Total U.S.	11.04	10.43	9.52	9.86	10.11	10.88	11.90	10.83	11.24	11.41	10.79	9.44	9.31	

Source: American Petroleum Institute; Energy Information Administration

with available deliverable supply much greater than demand. Surplus deliverability was in excess of 20% in 1983. At that time, dry gas deliverability was estimated at around 20,200 bcf. And U.S. dry gas production was only 16,033 bcf. This left a surplus of 4,167 bcf.

The deliverability surplus has been reduced in recent years. The drop is primarily due to a decline in deliverability, but demand has also been moving back up. Dry gas deliverability in 1987 was estimated at 18,600 bcf. Estimated deliverability fell to 18,000 bcf in 1988 and to 17,500 bcf in 1989. At the same time there was an increase in dry gas production to 16,536 bcf in 1987, to 16,992 bcf in 1988 and to 17,115 bcf in 1989. These production increases also have helped to reduce the surplus. The result of these moves has been a drop in the deliverability surplus to an estimated 2,064 bcf in 1987, 1,008 bcf in 1988 and only 385 bcf in 1989. This would in icate that the gap has been closed. However, there is a good chance that some additional deliverability has been developed since those estimates were made.

PRICES. Changing natural gas and other energy prices have been a major factor affecting the natural gas industry over the past fifteen years.

Over the ten-year period, 1973–82, the average wellhead price of natural gas went up 1,118.2%, from $0.22/mcf in 1973 to $2.46/mcf in 1982. That is an average annual increase of 30.8%. Over this period the relationship between crude oil and natural gas prices changed markedly. The cost of natural gas relative to crude oil increased about 50%. As a result, natural gas lost some competitive advantage and began to lose share of the energy market.

Natural gas demand began to fall in 1981 and 1982. But even in the face of falling demand, prices continued to move up throughout 1981 and 1982. Long-term contracts, entered into when the outlook was for a future natural gas shortage, continued to push up prices. Because of the take-or-pay provisions in most of these contracts, when demand began to fall, it became advantageous for the pipelines purchasing gas to continue to take high-priced gas and curtail acceptance of the lower-priced gas. This aggravated the problem and drove the prices higher.

Even though the price of crude oil and heavy fuel oil was falling and demand for natural gas was declining, the price of natural gas continued to move up in 1983 and 1984. But price increases were somewhat more moderate during 1983 and 1984. The average wellhead price moved up 5.3% in 1983, to $2.59/mcf, and up a modest 2.7% in 1984, to $2.66/mcf. Over the entire span, 1974 to the peak price year of 1984, the price increased $2.44/mcf.

Over that same period, the price paid for natural gas by electric utility plants increased $3.37/mcf, from $0.35/mcf in 1973 to $3.72/mcf

in 1984. The residential price moved up $4.77/mcf from $1.29/mcf in 1973 to $6.06/mcf in 1984.

The price paid for natural gas by electric utilities moved up 963%, and the residential price for natural gas moved up 369.8% over the 1973–84 period. These huge price increases led to a great deal of conservation and fuel switching on the part of gas consumers. Faced with an increase in natural gas energy costs of that magnitude, a major effort was made by all consumers to conserve on natural gas consumption.

In response to the falling prices of competing fuels and declining natural gas demand, natural gas prices started to fall in 1985. The price decline accelerated in 1986 and continued into 1987 and 1988. But as in the past, in 1986 the natural gas industry did not react quickly enough to the sharp drop in crude oil prices, and demand and market share were lost. In mid-1986, for the first time on record, the price paid by steam-electric utility plants for heavy oil fell below natural gas. The price per million BTU for heavy oil fell below natural gas in April 1986 and remained lower through October 1986. The price per million BTU for heavy oil fell as low as $1.841 in July 1986. The natural gas price in July was $2.161 per million BTU. As a result of this change in price relationships, natural gas lost market share to fuel oil in the utility sector in 1986.

In addition to competition from other fuels, increased gas to gas competition had been putting downward pressure on prices. With excess deliverability, gas producers and distributors were competing with each other for the same customers. This had the effect of lowering gas prices without substantially increasing demand for natural gas.

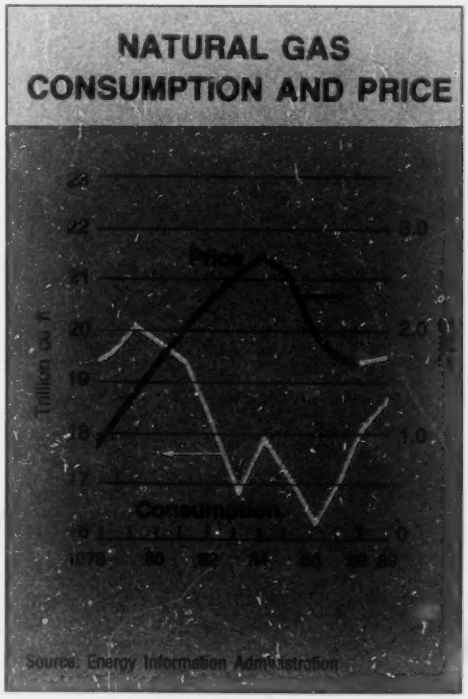
However, the average U.S. wellhead price for natural gas moved up slightly to $1.69/mcf in 1988. This modest increase was due to increased demand for natural gas. Demand was up 4.6% in 1988. The price in 1988 was down $0.97/mcf, 36.5%, from the peak of $2.66/mcf in 1984. The impact of the price drop is being felt in

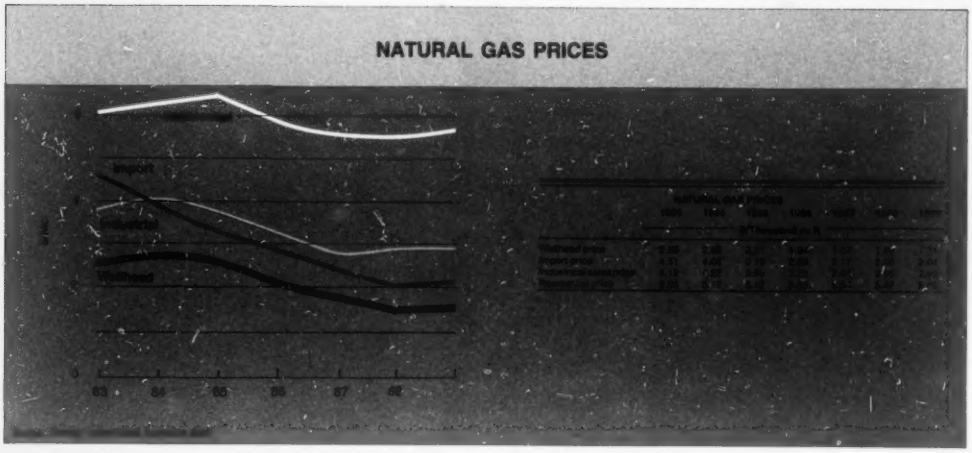
MARKETED PRODUCTION OF NATURAL GAS BY STATES*

State	1983	1984	1985	1986	1987	1988	1989
	(Billion cu ft)						
Alabama	90.8	101.8	107.3	107.2	117.2	129.5	128.3
Alaska	276.7	289.1	321.3	304.8	359.8	379.6	388.2
Arkansas	127.6	135.2	155.1	131.1	141.2	166.6	168.3
California	415.3	476.3	491.3	462.2	424.6	359.4	371.9
Colorado	163.5	173.3	178.2	163.7	164.6	191.5	203.8
Florida	21.1	12.6	10.5	8.8	8.3	7.5	8.0
Kansas	434.7	466.0	512.9	465.7	457.1	576.3	587.1
Louisiana	5,332.1	5,825.1	5,013.7	4,895.4	5,122.5	5,130.3	5,138.7
Michigan	138.9	144.5	131.9	127.3	147.0	146.1	156.5
Mississippi	151.2	157.9	144.2	140.8	139.7	124.1	106.8
Montana	52.0	51.5	52.5	46.6	46.5	51.7	51.0
New Mexico	895.3	957.4	905.3	702.6	823.8	791.8	849.1
North Dakota	69.3	70.5	72.6	55.1	62.3	57.7	53.1
Oklahoma	1,730.1	1,985.9	1,936.3	1,917.5	2,004.8	2,106.6	2,153.1
Texas	5,938.6	6,185.0	6,052.7	6,151.8	6,126.3	6,286.0	6,210.8
Utah	63.2	74.7	83.4	90.0	87.2	101.4	118.7
W. Virginia	130.1	143.7	144.9	135.4	160.0	182.0	198.2
Wyoming	444.0	516.7	416.6	403.3	498.0	509.1	599.7
Others	347.8	462.4	467.3	481.6	457.6	462.1	463.5
Total	16,822.1	18,229.6	17,198.0	16,790.9	17,348.5	17,808.3	17,954.8
Volume change	−1,698	1,407	−1,032	−407.1	557.6	459.8	146.5
Percent change	−9.2	8.4	−5.7	−2.4	3.3	2.7	0.8

*Includes nonhydrocarbon gases.

Source: Energy Information Administration





the consumption and production of natural gas, both of which are on the rise. With increased demand, the price of natural gas inched up again in 1989 to $1.71/mcf.

CONSUMPTION. Consumption of natural gas fell from 22.05 trillion cu.ft. in 1973 to 16.84 trillion cu.ft. in 1983, a drop of 23.6%. It rebounded to 17.95 trillion cu.ft. in 1984, an increase of 6.6% from the previous year. It dropped slightly to 17.28 trillion cu.ft. in 1985. It then fell sharply to 16.221 trillion cu.ft. in 1986.

The drop in gas prices and more aggressive marketing has helped boost consumption in 1987 and 1988. Consumption in 1987 jumped back up to 17.211 trillion cu.ft. and it continued up in 1988 to 18.028 trillion cu.ft. in 1988. The increase in natural gas consumption continued to climb in 1989 to 18.812 trillion cu.ft. The increase in crude oil prices in 1987 helped to boost natural gas demand. The competitive advantage of natural gas in the utility and heavy industry markets increased and there was a shift to natural gas as the fuel of choice. However, crude oil prices fell again in 1988 and natural gas consumption continued to increase. This indicates that natural gas is solidifying its share of the energy market.

Natural gas has held a cost advantage over heating oil in the residential market, and a cost advantage over residual fuel oil in the utility and industrial sectors. By 1982, a substantial portion of this cost advantage had eroded. Therefore, natural gas found itself facing competition it had not encountered before. In the residential sector, conversions from home heating oil to natural gas slowed. And in the industrial and utilities sectors, natural gas fell victim to the recession and to competition from other fuels. The Fuel Use Act which existed then also contributed to the problem. The regulations gave utilities and heavy industry low priority in the case of a natural gas supply curtailment. Without supply assurances, utilities and industry sought other fuels. The Fuel Use Act also restricted expansion of gas generation facilities.

In addition, utilities and industry moved toward installing multiple fuel capabilities, so they would have the flexibility totake advantage of any price differential between fuels. The volume of multi-fuel capacity increased markedly because of the high cost of energy. This resulted in intense competition for natural gas in many of its historical markets. If energy prices move up again, multi-fuel capability may also become prevalent in future years for residential and commercial heating.

In order to compete, the gas industry has

had to adjust prices to meet this fuel competition. And the recent natural gas price adjustments have increased its competitive position and stimulated consumption.

SUPPLY AND PRODUCTION. Marketed production of natural gas in the U.S. followed demand, falling from 22,648 billion cu.ft. in 1973 to 16,822 billion cu.ft. in 1983, down 25.7%. Production moved up in 1984 to 18,230 billion cu.ft., an increase of 8.4%. However, production fell again in 1985, down 5.7% to 17,198 billion cu.ft. Domestic production continued this downward movement, falling to 16,791 billion cu.ft. in 1986. This was the lowest level of domestic marketed production since 1965.

With increased demand, production has moved up in the last three years, 1987 through 1989. Production increased to 17,349 billion cu.ft. in 1987, 17,808 billion cu.ft. in 1988 and 17,955 billion cu.ft. in 1989.

When natural gas prices were rising there was no concern about the availability of natural gas. The higher gas prices stimulated the supply side for natural gas. Exploration and production activity moved up sharply during the drilling boom years 1979–82. The number of gas wells completed moved up from 3,983 in 1971 to 19,742 in 1981 and 18,363 in 1982. And the number of completions remained relatively high over the 1983–84 period. Gas well completions dropped to 14,619 in 1983, then moved up to 17,201 in 1984. But gas well drilling has slipped in recent years, falling to 12,875 in 1985, 8,096 in 1986 and 8,114 in 1987. With increased demand, gas well drilling showed some improvement in 1988 and 1989. Gas well completions moved up to 8,697 in 1988 and 9,708 in 1989.

Gas well drilling had been depressed due to a combination of low demand and low prices. Low demand had a particularly large impact on the economics of gas well drilling. Because of low demand, and a gas surplus, some gas wells had to be shut in. There was no guaranteed market for gas, and this sharply reduced the incentive for drilling. This environment has changed along with the increased consumption of natural gas.

PRODUCTION, IMPORTS

	Total marketed prod.	Imports	Total new supply*	Imports % total supply
	(Billion cu ft)			
1973	22,648	1,033	23,681	4.4
1974	21,601	959	22,560	4.3
1975	20,109	953	21,062	4.5
1976	19,952	964	20,916	4.6
1977	20,025	1,011	21,036	4.8
1978	19,974	966	20,940	4.6
1979	20,471	1,253	21,724	5.8
1980	20,180	985	21,165	4.7
1981	19,956	904	20,860	4.3
1982	18,520	933	19,453	4.8
1983	16,822	920	17,742	5.2
1984	18,230	843	19,073	4.4
1985	17,198	949	18,147	5.2
1986	16,791	750	17,541	4.3
1987	17,349	992	18,341	5.4
1988	17,808	1,294	19,102	6.8
1989	17,955	1,378	19,333	7.1

*Before losses.

Source: Energy Information Administration

With high production rates and little new development, U.S. natural gas reserves fell between 1973 and 1979. Natural gas reserves fell sharply from 249,950 billion cu.ft. in 1973 to 194,917 billion cu.ft. in 1979, down 22%. The reserves-production rate fell from 11.04 years in 1973 to 9.52 years in 1979.

However, with the increased exploration and drilling activity, reserves were sustained and actually increased slightly between 1979 and 1984. However, with the decline in drilling reserves began to fall again, dropping to 187,211 billion cu.ft. in 1987. But because of the low level of production, the reserves production ratio was up to 10.79 years. Reserves fell only marginally in 1988 to 187,200 billion cu.ft. The reserves to production ratio slipped to 10.73 years. The drop in

reserves in recent years may have a significant impact on future deliverability.

There has been some concern expressed about the impact of natural gas imports on domestic production, and imports have been moving up rapidly in recent years. From 1973 through 1985, annual natural gas imports ranged from 904 billion cu.ft. to 1,253 billion cu.ft. As a percentage of total supply they ranged from 4.1% in 1974 and 1981 to 5.5% in 1979. The average was 4.5% of total supply. Imports fell to 750 billion cu.ft. in 1986, only 4% of total supply. This was the lowest level of imports since 1969. But when demand rebounded in 1987, imports jumped up to 992 billion cu.ft., 5.1% of supply. Imports continued to move up in 1988 to 1,294 billion cu.ft., 6.3% of total supply. In 1989, imports moved up to 1,382 billion cu.ft., 6.5% of supply. Almost all of the imports are from Canada. As demand has been on the rise in recent years, Canada has been increasing its gas export capacity. In the past, import prices were higher than domestic prices. Therefore, there was no great incentive to increase import volumes. Imports filled a small gap between domestic production and consumption, and were concentrated in certain regional areas. However, Canada has adjusted prices to be more competitive in the U.S. market. And it is investing in capacity to increase exports to the U.S., particularly into the growing Northeastern market.

Natural Gas Liquids (NGL) production fell along with natural gas during the years of decline, but not at the same rate. Marketed production of natural gas in 1985 was down 24.1% from 1973. However, NGL production in 1985 was 1.609 million b/d, down only 7.4% from 1973. Natural gas production fell another 2.4% in 1986 and NGL production fell 3.6%. In 1987, natural gas production moved up 2.2%. NGL output was up 2.8%. Natural gas production increased 0.6% in 1988 and NGL production moved up 1.9%, to 1.625 million b/d. In 1989, natural gas production increased 0.8% and NGL production fell 4.9%, to 1.546 million b/d.

Over the 1973–85 period the NGL extraction rate was on the ise. The quantity of gas processed fell 32%, but the extraction rate improved substantially. The volume of natural gas liquids recovered per mcf has increased from 1.353 gallons in 1973 to an estimated 1.814 gallons in 1983. This is an increase of 34.1% in the liquid extraction level. The level of extraction is tied to the relative value of the liquids versus the value of the natural gas with a higher liquids content. The extraction rate is still higher than in the 1970s but it has slipped in recent years. It was down to 1.622 gallons per mcf in 1987 and 1.629 gallons per mcf in 1988. It fell sharply in 1989, 1.32 gallons per mcf.

OUTLOOK

The expectations expressed for the domestic and worldwide natural gas industry over an extended period are very favorable. The optimism seems to revolve around some of the inherent advantages of natural gas as a fuel. Expectations are for increasing consumption of natural gas both in the U.S. and elsewhere in the world. And it is felt that there is a substantial domestic and international resource base to support an increase in future consumption.

In recent years the natural gas industry has found itself in the role of "swing fuel source" in a very competitive energy market. Structural problems slowed the industry response to rapidly changing competitive conditions, making it difficult for natural gas to respond to the rapid price changes in the energy industry. The structure of the industry with government price, production and consumption regulations and with cumbersome contract problems made it less responsive to market changes.

However, the industry has made changes to position itself for expansion in the future. The contract problems are being resolved and operations streamlined. The natural gas industry is beginning to become more aggressive in market-

ing, and this will help it to sustain existing markets and to expand into new markets. The burdensome morass of government regulations is being reduced and/or eliminated. And of prime importance, pricing has become much more flexible and responsive to competing market forces.

Over the forecast period, natural gas is expected to face a great deal of competition from competing fuels. The drop in crude oil prices in 1986 substantially increased the competition from distillate and residual fuel oil. That will change during the Middle East crisis. Coal already has a price advantage in many areas and is expected to sustain it during the forecast period. It is estimated that more than 40% of the gas market, possibly 6 to 8 trillion cu.ft., are in the swing market. This is a market with the ability to switch to other energy sources.

In this era of environmental concern, natural gas has an advantage as a very clean-burning, non-polluting fuel source. Another advantage is the fact that there appears to be a substantial supply available. The domestic reserve base may prove to be much larger than estimated, particularly if an increase in prices stimulates additional exploration. And there are substantial additional North American supplies available, particularly from Canada.

Worldwide, there are also substantial reserves. However, a large portion are located in areas far from major consuming countries. Over time it is expected that the transportation problem will be resolved and costs reduced. This will stimulate international gas trade and increase worldwide consumption.

The recent crisis in the Middle East is not expected to have a major impact on the outlook for natural gas in the long run, but it is expected to have an impact over the shorter five-year forecast period of this outlook.

The conflict in the Middle East has resulted in much higher worldwide crude oil prices. The sharp reduction in worldwide crude oil supply pushed up the average price of world export crude oils 50% in the three weeks following the invasion. This has also resulted in higher wellhead oil prices in the U.S.

The higher oil prices will increase the cost of energy for economic growth. The much higher prices of energy are expected to slow the growth in demand for energy. With natural gas as the swing fuel, the growth in demand for natural gas may also be affected. Therefore the length of time that prices remain elevated will play a role in determining the trend in the natural gas industry over the forecast period.

At this time it is uncertain how long the crisis involving Iraq and Kuwait will last. It is quite probable that the loss of this volume of crude oil will exert upward pressure on crude oil prices as long as the crisis continues. This makes it almost impossible to project with any certainty the most likely trend in natural gas industry activity over the forecast period.

Therefore, in this edition of the Oil Industry Outlook, three scenarios are being presented. The three scenarios vary in expectations of the length of time the crisis in the Persian Gulf will last. The length of time the oil crisis continues will determine the trend in the price of crude oil and therefore the trend in energy demand and natural gas demand. To cover these variations three separate forecasts are presented. The forecast with the highest degree of probability is the one that comes closest to estimating the length of time it takes to finally resolve this issue in the Middle East, and for Iraqi and Kuwaiti oil to return to the market. Following is a brief review of the key points of each scenario. They are discussed in more detail in earlier chapters.

Scenario I—The embargo of oil exported from Iraq and Kuwait continues for a period of 6–18 months. The vast majority of oil production in Iraq and Kuwait is shut in for the duration of the dispute. Oil production capacity in other OPEC areas is not affected by the dispute. Following the settlement of the dispute, production in Iraq and Kuwait is resumed at previous levels.

Scenario II—The embargo of oil exported from Iraq andKuwait continues for a period of 18–30 months. The vast majority of oil production in Iraq and Kuwait is shut in for the extended duration of the dispute. Oil production capacity in other OPEC areas is not affected by the dispute. Following the settlement of the dispute, production in Iraq and Kuwait is resumed at previous levels.

Scenario III—The embargo of oil exported from Iraq and Kuwait continues for less than six months. The vast majority of oil production in Iraq and Kuwait is shut in during this period. Production capacity in other OPEC countries is not affected by this dispute. Following settlement of the dispute, production in Iraq and Kuwait is resumed at previous levels.

The major differences between the three scenarios is the length of time that the crisis continues and Iraqi and Kuwaiti oil is off the market. But even though the length of time until settlement of the dispute is the only apparent difference, these three scenarios will cause three distinct sets of conditions in the oil market. And the different market conditions will create differing projections of price, energy demand and natural gas demand over the forecast period, 1991–95.

SCENARIO I—The loss of the large volume of crude oil from the Middle East will boost crude oil prices through 1991. The higher oil and energy prices will slow economic growth and growth in energy demand in 1991. U.S. natural gas prices will move up, but not at the rapid rate of oil prices. Natural gas demand will fall marginally in 1991 due to the slower growth in energy demand. Natural gas demand in 1991 will slip to 18,490 billion cu.ft., down 575 billion cu.ft. Oil prices will fall in 1992 after the settlement of the dispute. This will help stimulate economic growth and demand for energy. Consumption of natural gas will increase in 1992, moving up 410 billion cu.ft. to 18,900 billion cu.ft. Oil and natural gas prices will move up gradually over the remainder of the forecast period. Increased economic activity and energy consumption will result in increased demand for natural gas. Demand for natural gas in 1995 will be 20,330 billion cu.ft., up 1,765 billion cu.ft. from 1990.

U.S. marketed production will follow demand over the forecast period. Production will dip in 1991 but then rebound in 1992. Production will move up over the forecast period to 19,635 billion cu.ft. in 1995. Imports will move up faster than total demand or domestic production. Imports, mainly from Canada, will increase to 1,890 billion cu.ft. in 1995, up 21.9% from 1990.

The key to growth in natural gas consumption is a competitive price level. Gas prices will remain competitive but will move up because of the reduction or elimination of the deliverability surplus. Natural gas prices are forecast to climb throughout the forecast period. The average U.S. wellhead price is expected to move up 31.4% by 1995, to $2.30/mcf. The residential price will increase 22.7%, to $7.30/mcf in 1995. Over the forecast period, 1991–95, the rate of increase in natural gas prices will be greater than the rate for crude oil. However, natural gas prices tend to lag behind crude prices and the price rise will not be as great as the increase in oil prices from 1989 to 1995. Natural gas prices will be up 31.4% from 1990 to 1995 while oil prices will be up 35.6% from 1989 to 1995. Therefore natural gas will maintain its competitive position with respect to other competing fuels and not lose energy market share.

SCENARIO II—The loss of the large volume of crude oil from the Middle East will boost crude oil prices through 1991 and 1992. The higher oil and energy prices will slow economic growth, and growth in energy demand in 1991 and 1992. U.S. natural gas prices will move up, but not at the rate of oil prices. Natural gas demand will fall marginally in 1991 due to the slower growth in energy demand. Natural gas demand in 1991 will slip to 18,490 billion cu.ft., down 575 billion cu.ft. Demand will slip again in 1992, falling 305 billion cu.ft. to 18,185 billion cu.ft. Oil

prices will fall in 1993 after the settlement of the dispute. This will help stimulate economic growth and demand for energy. Consumption of natural gas will increase in 1993, moving up 560 billion cu.ft. to 18,745 billion cu.ft. Oil and natural gas prices will move up gradually over the remainder of the forecast period. Increased economic activity and energy consumption will result in increased demand for natural gas. Demand for natural gas in 1995 will be 19,535 billion cu.ft., up 970 billion cu.ft. from 1990.

U.S. marketed production will follow demand over the forecast period. Production will dip in 1991 and 1992 but then rebound in 1993. Production will move up over the remainder of the forecast period to 18,835 billion cu.ft. in 1995. Imports will move up faster than demand or domestic production. Imports mainly from Canada will increase to 1,850 billion cu.ft. in 1995, up 19.4% from 1990.

The key to growth in natural gas consumption is a competitive price level. Gas prices will remain competitive but will move up because of the reduction or elimination of the deliverability surplus. Natural gas prices are forecast to climb throughout the forecast period. The average U.S. wellhead price is expected to move up 28.6% by 1995, to $2.25/mcf. The residential price will increase 20.2%, to $7.15/mcf in 1995. Over the forecast period, 1991–95, the rate of increase in natural gas prices will be greater than the rate for crude oil. However, natural gas prices tend to lag behind crude prices and the price rise will not be quite as great as the increase in oil prices from 1989 to 1995. Natural gas prices will move up 28.6% between 1990 and 1995 while crude oil prices will be up 31.9% from 1989 to 1995. Therefore natural gas will maintain its competitive position with respect to other competing fuels and not lose energy market share.

SCENARIO III—The loss of the large volume of crude oil from the Middle East will boost crude oil prices only through the remainder of 1990 and possibly into early 1991. The higher oil and energy prices will not significantly slow economic growth, and growth in energy demand. Oil prices will fall in 1991 and then climb over the remainder of the forecast period. U.S. natural gas prices will move up over the forecast period, but not at the rate of oil prices. The relatively low prices will stimulate economic growth and energy consumption. Natural gas demand will increase throughout the forecast period due to this continued economic growth, and growth in energy demand. Demand for natural gas in 1995 will be 21,080 billion cu.ft., up 2,470 billion cu.ft. from 1990.

U.S. marketed production will follow demand over the forecast period. Production will move up over the forecast period to 20,400 billion cu.ft. in 1995. Imports will move up faster than demand or domestic production. Imports mainly from Canada will increase to 1,920 billion cu.ft. in 1995, up 23.9% from 1990.

The key to growth in natural gas consumption is a competitive price level. Gas prices will remain competitive but will move up because of the reduction or elimination of the deliverability surplus. Natural gas prices are forecast to climb throughout the forecast period. The average U.S. wellhead price is expected to move up 37.1% by 1995, to $2.40/mcf. The residential price will increase 26.1%, to $7.50/mcf in 1995. Over the forecast period 1991–95, the rate of increase in natural gas prices will be greater than the rate for crude oil. However, natural gas prices tend to lag behind crude prices and the price rise will not be quite as great as the increase in oil prices from 1989 to 1995. Natural gas prices in 1995 will be up 37.1% from 1990 while crude oil prices will have moved up 38.8% over the 1989–95 period. Therefore natural gas will maintain its competitive position with respect to competing fuels and not lose energy market share.

Environmental concerns about the continued consumption of coal and heavy fuel oil may also give a boost to natural gas demand.

Fuel to generate electric power should be on the rise over the forecast period. However, coal

consumption growth for power generation may be slower than projected due to the environmental concerns. And growth in nuclear generation is expected to peak in 1993. Therefore a widening gap may develop for natural gas.

Imports are expected to move up over the forecast period. Almost all of the imports will be from Canada. But there also may be small volumes of LNG imports from Algeria and Indonesia over the forecast period. Basic demand in the U.S. is moving up and some new markets are opening up in the Northeast. The Canadians are expanding their pipeline system and production capacity to meet this new demand. Additional U.S. pipeline capacity to the expanding markets will be required.

Deliverability surplus is not expected to be a problem. The increase in demand is expected to exceed any increase in deliverability. Additional exploration and drilling activity should increase actual total deliverability in the future. But although drilling activity will increase over the forecast period, it is not expected to be sufficient to create a large deliverability surplus. It is expected that deliverability will remain somewhat in balance with demand.

If some of the problems associated with government regulations are removed, the industry could come closer to reaching its full potential. The development of the spot market for natural gas and the increase in contract carriage are already making the natural gas industry more flexible and competitive. This will help natural gas retain its market share.

NATURAL GAS
KEYS TO THE FUTURE
SCENARIO I

1. Oil prices will remain high through 1991.This will slow economic growth, and growth in energy demand. As a result, demand for natural gas, the swing fuel, will fall in 1991.

2. Oil prices will fall in 1992 after the Middle East dispute is settled. This will stimulate economic growth and energy demand. Natural gas demand will rebound. Natural gas demand will increase over the remainder of the forecast period stimulated by relatively low prices and continued economic growth. Demand will be up 9.5% in 1995, at 20.33 tcf.

3. Marketed production of natural gas in the U.S. will move with demand, falling in 1991 and then increasing over the remainder of the forecast period. Nuclear power growth will peak in 1993 and may open a gap for natural gas for electric power generation. Production in 1995 will be up 8.4% over 1990.

4. Natural gas prices will move up over the forecast period. The closing of the demand/deliverability gap will put some upward pressure on prices. However gas prices will remain competitive with competing fuels, moving up at a pace similar to crude oil prices over the period 1989–95. Wellhead natural gas prices will be 31.4% higher in 1995.

5. Imports will increase, due to increased demand and an expanding market in the Northeastern U.S. Imports will move up faster than either demand or domestic production. Imports will be 21.9% higher in 1995.

THE OUTLOOK—NATURAL GAS
SCENARIO — I

	1989	1990	1991	1992	1993	1994	1995	Change 1990 to 1995	% change 1990 to 1995
NATURAL GAS VOLUMES									
(billion cubic feet)									
Marketed production	17,955	18,120	18,000	18,370	18,865	19,215	19,635	+1,515	+ 8.4
Imports	1,378	1,550	1,585	1,650	1,730	1,820	1,890	+340	+21.9
Demand	18,812	18,565	18,490	18,900	19,445	19,865	20,330	+1,765	+ 9.5
SECTOR NATURAL GAS DEMAND									
(billion cubic feet)									
Residential	4,748	4,637	4,620	4,660	4,675	4,685	4,705	+68	+ 1.5
Commercial	2,697	2,642	2,630	2,670	2,700	2,725	2,755	+113	+ 4.3
Industrial	6,842	6,871	6,825	7,020	7,155	7,225	7,290	+419	+ 6.1
Electric utilities	2,768	2,645	2,650	2,765	3,105	3,400	3,720	+1,075	+40.6
Pipeline & plant fuel	1,757	1,770	1,765	1,785	1,810	1,830	1,860	+90	+ 5.1
Total demand	**18,812**	**18,565**	**18,490**	**18,900**	**19,445**	**19,865**	**20,330**	**+1,765**	**+ 9.5**
PRICES									
U.S. wellhead price									
($ per thousand cubic feet)	1.71	1.75	1.85	2.00	2.10	2.20	2.30	+ 0.55	+ 31.4
Residential price									
($ per thousand cubic feet)	5.63	5.95	6.25	6.60	6.85	7.05	7.30	+1.35	+ 22.7

NATURAL GAS
KEYS TO THE FUTURE
SCENARIO II

1. Oil prices will remain high through 1991 and 1992. This will slow economic growth, and growth in energy demand over this period. As a result, demand for natural gas, the swing fuel, will fall in 1991 and 1992.

2. Oil prices will fall in 1993 after the Middle East dispute is settled. This will stimulate economic growth and energy demand. Natural gas demand will rebound. Natural gas demand will increase over the remainder of the forecast period stimulated by relatively low prices and continued economic growth. Demand will be up 5.2% in 1995, at 19.535 tcf.

3. Marketed production of natural gas in the United States will move with demand, falling in 1991 and 1992 and then increasing over the remainder of the forecast period. Nuclear power growth will peak in 1993 and may open a gap for natural gas for electric power generation. Production in 1995 will be up 3.9% over 1990.

4. Natural gas prices will move up over the forecast period. The closing of the demand/deliverability gap will put some upward pressure on prices. However, gas prices will remain competitive with competing fuels, moving up at a pace similar to crude oil prices over the period 1989–95. Wellhead natural gas prices will be 28.6% higher in 1995.

5. Imports will increase, due to increased demand and an expanding market in the Northeastern U.S. Imports will move up faster than either demand or domestic production. Imports will be 19.4% higher in 1995.

THE OUTLOOK—NATURAL GAS
SCENARIO — II

	1989	1990	1991	1992	1993	1994	1995	Change 1990 to 1995	% change 1990 to 1995
NATURAL GAS VOLUMES									
(billion cubic feet)									
Marketed production	17,955	18,120	18,000	17,630	18,150	18,465	18,835	+715	+ 3.9
Imports	1,378	1,550	1,585	1,630	1,700	1,780	1,850	+300	+ 19.4
Demand	18,812	18,565	18,490	18,185	18,745	19,120	19,535	+970	+ 5.2
SECTOR NATURAL GAS DEMAND									
(billion cubic feet)									
Residential	4,748	4,637	4,620	4,600	4,630	4,670	4,680	+43	+ 0.9
Commercial	2,697	2,642	2,630	2,585	2,650	2,690	2,720	+78	+ 3.0
Industrial	6,842	6,871	6,825	6,660	6,960	7,035	7,105	+234	+ 3.4
Electric utilities	2,768	2,645	2,650	2,600	2,725	2,925	3,210	+565	+21.4
Pipeline & plant fuel	1,757	1,770	1,765	1,740	1,780	1,800	1,820	+50	+ 2.8
Total demand	**18,812**	**18,565**	**18,490**	**18,185**	**18,745**	**19,120**	**19,535**	**+970**	**+ 5.2**
PRICES									
U.S. wellhead price									
($ per thousand cubic feet)	1.71	1.75	1.85	2.00	1.95	2.10	2.50	+ 0.50	+ 28.6
Residential price									
($ per thousand cubic feet)	5.63	5.95	6.25	6.60	6.45	6.80	7.15	+1.20	+ 20.2

NATURAL GAS
KEYS TO THE FUTURE
SCENARIO III

1. Oil prices will remain only through 1990. This will not appreciably slow economic growth, and growth in energy demand.

2. Oil prices will fall in 1991 after the Middle East dispute is settled. This will stimulate economic growth and energy demand. Natural gas demand will increase over the forecast period stimulated by relatively low prices and continued economic growth. Demand will be up 13.3% in 1995, at 21.08 tcf.

3. Marketed production of natural gas in the United States will move with demand, increasing over the forecast period. Nuclear power growth will peak in 1993 and may open a gap for natural gas for electric power generation. Production in 1995 will be up 12.3% over 1990.

4. Natural gas prices will move up over the forecast period. The closing of the demand/deliverability gap will put some upward pressure on prices. However, natural gas prices will remain competitive with competing fuels, moving up at a pace similar to crude oil prices over the period 1989–95. Wellhead natural gas prices will be up 37.1% in 1995.

5. Imports will increase, due to increased demand and an expanding market in the Northeastern U.S. Imports will move up faster than either demand or domestic production. Imports will be 23.9% higher in 1995.

THE OUTLOOK—NATURAL GAS
SCENARIO — III

	1989	1990	1991	1992	1993	1994	1995	Change 1990 to 1995	% change 1990 to 1995
NATURAL GAS VOLUMES									
(billion cubic feet)									
Marketed production	17,955	18,170	18,445	18,955	19,475	19,920	20,400	+2,230	+12.3
Imports	1,378	1,550	1,595	1,680	1,770	1,850	1,920	+370	+23.9
Demand	18,812	18,610	18,915	19,480	20,060	20,560	21,080	+2,470	+13.3
SECTOR NATURAL GAS DEMAND									
(billion cubic feet)									
Residential	4,748	4,649	4,665	4,680	4,690	4,705	4,720	+71	+ 1.5
Commercial	2,697	2,649	2,675	2,700	2,720	2,745	2,770	+121	+ 4.6
Industrial	6,842	6,890	7,025	7,160	7,295	7,430	7,560	+670	+ 9.7
Electric utilities	2,768	2,652	2,765	3,130	3,515	3,815	4,140	+1,488	+56.1
Pipeline & plant fuel	1,757	1,770	1,785	1,810	1,840	1,865	1,890	+120	+ 6.8
Total demand	**18,812**	**18,610**	**18,915**	**19,480**	**20,060**	**20,560**	**21,080**	**+2,470**	**+13.3**
PRICES									
U.S. wellhead price									
($ per thousand cubic feet)	1.71	1.75	1.90	2.05	2.15	2.30	2.40	+ 0.65	+ 37.1
Residential price									
($ per thousand cubic feet)	5.63	5.95	6.35	6.70	6.95	7.30	7.50	+1.55	+ 26.1

OTHER ENERGY SOURCES

The embargo on oil exports from Iraq and Kuwait has pushed up the price of oil substantially. One of the effects of this increase in the price of oil could very possibly be a worldwide and domestic slowdown in economic growth. The increase in the price of oil will mean generally higher energy costs. And this will result in the diversion of capital from other productive activity to purchasing basic energy.

ELECTRICITY GENERATION AND FUEL CONSUMPTION

	Total electricity generated (Billion kwh)	Fuels consumed: Coal (1,000 st)	% of total	Petroleum (1,000 bbl)	% of total	Natural gas (Bcf)	% of total	Nuclear, hydro & other % of total
1975	1,917.6	405,962	44.5	506,128	15.1	3,157.7	15.6	24.8
1976	2,037.7	448,371	46.4	555,920	15.7	3,060.9	14.4	23.5
1977	2,124.3	477,126	46.4	623,705	16.9	3,191.2	14.4	22.3
1978	2,206.3	481,235	44.2	635,839	16.6	3,188.4	13.8	25.4
1979	2,247.4	527,051	47.8	523,297	13.5	3,490.5	14.7	24.0
1980	2,286.4	569,274	50.8	420,214	10.8	3,681.6	15.1	23.3
1981	2,294.8	596,797	52.4	351,111	9.0	3,640.2	15.1	23.5
1982	2,241.2	59,,666	53.2	249,771	6.6	3,225.5	13.6	26.6
1983	2,310.3	625,211	54.5	245,497	6.3	2,910.8	11.9	27.3
1984	2,416.3	664,399	55.5	204,479	5.0	3,111.3	12.3	27.2
1985	2,469.8	693,841	56.8	173,414	4.1	3,044.1	11.8	27.3
1986	2,487.3	685,056	55.7	230,482	5.5	2,602.4	10.0	28.8
1987	2,572.1	717,894	56.9	199,378	4.6	2,844.1	10.6	27.9
1988	2,704.3	758,372	57.0	248,096	5.5	2,635.6	9.3	28.2
1989	2,780.8	765,620	55.8	266,836	5.7	2,767.9	9.5	29.0

Source: Energy Information Administration

With energy being more costly, it is highly probable that consumption of energy will decrease. And it is also highly probable that there will be fuel switching and other movements away from the higher-cost type of energy.

One of the fundamental requirements for sustaining economic activity or achieving economic growth is energy. Energy is a necessary input for all economic activity. The need for energy to fuel economic activity has not changed. What has changed to a degree is the quantity of energy required and the type of energy consumed.

Energy growth and economic growth moved up at about the same rate for an extended period. All through the growth years of the 1950s and 1960s, energy growth and economic growth moved up at the same rate. During that period, energy was inexpensive relative to other costs and therefore was consumed only with concern for increased production. There was little concern for energy conservation. But that relationship between economic growth and energy growth changed markedly when the price of oil and other energy increased rapidly in the 1970s. With the cost of energy moving up rapidly and having a major impact on production costs, a great deal more thought was given to energy conservation and minimizing the cost of energy.

In addition to the changing relationship between economic growth and energy, there has been a marked shift in the relative share of energy coming from major energy sources. In recent years, oil and natural gas have been losing market share to other basic energy sources: coal, nuclear, hydro, geothermal and others. In general, the other forms of energy are lower-cost sources of energy, and are therefore preferable, if there are no operational problems associated with their use.

Oil and natural gas are still the dominant energy sources and together supply 65% of the U.S. energy needs and 60% of worldwide energy needs. But they do not satisfy all energy needs. Petroleum and natural gas are, in fact, to a large extent the higher cost "swing fuels," satisfying energy needs not met by other fuels. This is particularly true with respect to energy for electrical generation and for heavy industry. Those sectors of the economy look to natural gas and petroleum only when there is insufficient energy available from cheaper fuel sources, such as coal, hydroelectric and nuclear. This has been particularly true since the 1970s, when the price of petroleum skyrocketed, and natural gas prices soon followed.

Petroleum does have its secure niche as a liquid fuel for transportation, a role that does not appear to be threatened by fuel switching. Most long-range forecasts do not envision any immediate major economic alternative for petroleum as a transport fuel. But even in this sector of economic activity, some alternatives have been introduced.

Automobiles and small trucks have been converted to use propane, and there is continuous experimentation with electric cars for short-range city transport.

Natural gas is capturing a substantial part of the home heating market. It has a definite advantage as a clean-burning, efficient, and relatively low-cost fuel. Natural gas also has an established market in the industrial and utility sectors, provided it remains price-competitive. Its advantage as a clean-burning, non-polluting fuel could translate into increased demand in the future. This is particularly true if environmental concerns about acid rain and clean air remain important political and environmental objectives. Given the current mood, it is almost a certainty that these and other environmental issues will be of primary concern over the forecast period.

At the low oil prices that occurred in 1986, all of the three major fuel sources—petroleum, natural gas and coal—were competing in the industrial market. It is likely that the future will see more competition between fuels due to the increased multi-fuel capacity of major consumers. The sharp increase in oil prices in 1990 could markedly change the economics of energy. This may depend on the length of time that oil prices remain at this higher level.

Oil prices have been going through a period of sharp cyclical changes influenced by OPEC production decisions, ever since 1986. But in general, recent oil prices have been much lower than in the preceding several years. In addition, natural gas prices moved down during this period in order to keep natural gas competitive with other fuels.

Lower energy prices tend to slow the conservation effort. And the lower cost of petroleum and natural gas markedly changes the economics of investing in capital equipment for conversion to other fuels. The lower cost of energy lengthens the pay-back period on the increased capital investment required for new capital equipment, and in many cases conversion is uneconomical.

COAL PRODUCTION

	Production	Consumption	Imports	Exports
	(1,000 short tons)			
1975	654,641	562,640	940	66,309
1976	684,913	603,790	1,203	60,021
1977	697,205	625,291	1,647	54,312
1978	670,164	625,225	2,953	40,714
1979	781,134	680,524	2,059	66,042
1980	829,700	702,729	1,194	91,742
1981	823,775	732,628	1,043	112,541
1982	838,111	706,910	742	106,277
1983	782,091	736,671	1,271	77,772
1984	895,921	791,291	1,286	81,483
1985	883,638	818,049	1,952	92,680
1986	890,315	804,312	2,212	85,518
1987	918,762	836,941	1,747	79,607
1988	950,265	883,664	2,134	95,023
1989	979,578	889,491	2,851	100,815
% chg 89 75	+ 49.6	+ 58.1	+ 203.3	+ 52.0

Source: Energy Information Administration

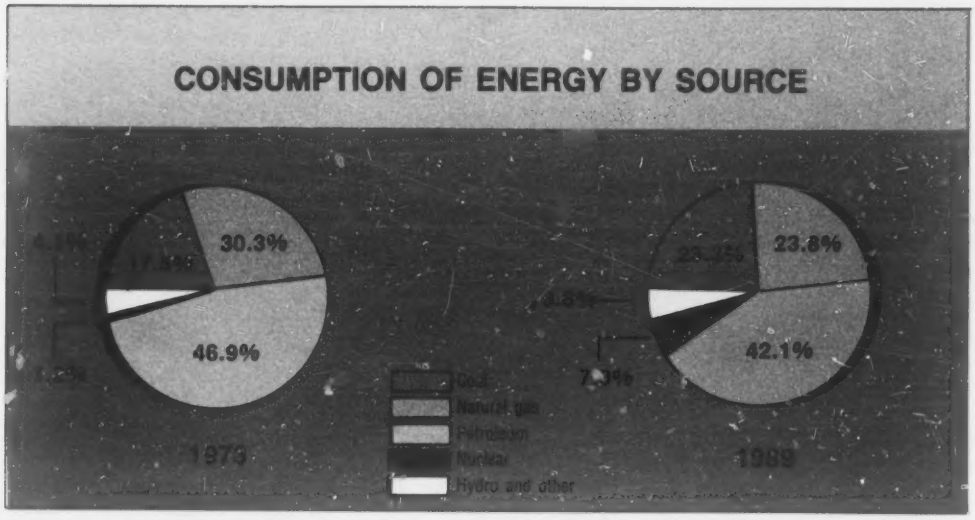
NUCLEAR POWER PLANT OPERATIONS

	Number of reactors	Electricity generated (Million net kwh)	% of total electricity generated	Net summer capability (Million net kw)	Capacity utilized (%)
1975	54	172,505	9.0	37,161	56.0
1976	61	191,104	9.4	43,657	54.9
1977	65	250,883	11.8	46,202	63.4
1978	70	276,403	12.5	50,709	64.7
1979	68	255,155	11.4	49,630	58.5
1980	70	251,116	11.0	51,668	56.4
1981	74	272,674	11.9	55,914	58.4
1982	77	282,773	12.6	59,927	56.7
1983	80	293,677	12.7	63,009	54.4
1984	86	327,634	13.6	69,652	56.3
1985	95	383,691	15.5	79,397	58.0
1986	100	414,038	16.6	85,241	56.9
1987	107	455,270	17.7	93,583	57.4
1988	108	526,973	19.5	94,695	63.5
1989	110	529,355	19.0	97,869	62.3
% chg 89 75	+ 103.7	+ 206.9	–	+ 163.4	–

Source: Energy Information Administration

However, with higher oil costs the economics have changed. Conversion or switching to other fuels becomes economical again. It also becomes cost-effective to enact conservation programs and to invest in more fuel-efficient equipment. But these decisions will not be made spontaneously, but will be studied carefully to determine the economic benefits. Therefore the length of time that the upward pressure on prices lasts could determine energy consumption patterns over the forecast period.

What happens with respect to total energy demand, and what happens with respect to demand for other forms of energy, will have a



major impact on the future for crude oil and natural gas. This section will review the recent trends in other energy sources.

REVIEW

The energy industry has gone through several major transitions and shifts in direction over the past 15 years. The frequent substantial changes in the cost of energy, have been one of the major reasons for the rapidly shifting conditions in the energy industry. Another factor having a major impact on energy requirements is the gradual shift of the economy to a more service oriented, less industrial economy. These two factors have greatly influenced the quantity and type of energy consumed.

Energy prices started to move up in the 1970s, following a long period of relatively low-cost energy. The increase was led by petroleum prices which first moved up in 1973–74, and then rapidly increased from 1979–81. Natural gas prices followed and also started accelerating upward in the late 1970s and early 1980s. Coal and electric power prices also followed.

Therefore, all forms of energy rapidly became more expensive during this time period. This huge increase in the cost of basic energy made it very attractive for energy users to find ways to conserve on their level of energy consumption. In addition, when prices for competing forms of energy were out of balance, it became cost-effective to switch, if possible, to other lower-cost forms of energy. Therefore, it became economically attractive to invest in capital equipment that would reduce energy consumption. And it became cost-effective to invest in equipment to establish multi-fuel capability, so that large fuel users could select the least costly fuel.

Over the same period, and even today, the economy was in transition to a more service-oriented and automated economy. This newly evolving economy is less energy-intensive than an economy dominated by heavy industry. In addition, there is an accompanying shift toward more electrical power consumption in the modern economy. All of these shifts had an impact on the quantity and type of fuel that was consumed.

Conservation led to a drop in energy consumption per unit of economic activity. Energy consumption per unit of GNP had been falling

ELECTRIC SECTOR: RELATION TO TOTAL PRODUCT DEMAND

	Total coal consumption	Coal consumed in electric generation	%	Total petroleum consumption	Petroleum consumed in electric generation	%	Total natural gas consumption	Natural gas consumed in electric generation	%
	— (1,000 short tons) —			(1,000 b/d)			(Bcf)		
1973	562,584	389,212	69.2	17,308	1,535	8.9	22,049	3,660.2	16.6
1979	680,524	527,051	77.4	18,513	1,433	7.7	20,241	3,490.5	17.2
1987	836,941	717,894	85.8	16,665	546	3.3	17,211	2,844.1	16.5
1988	883,664	758,372	85.8	17,283	678	3.9	18,028	2,635.6	14.6
1989	889,491	765,820	86.1	17,325	731	4.2	18,812	2,767.9	14.7

Source: Energy Information Administration

ELECTRICITY SALES

	Residential	Commercial	Industrial	Other	Total
			(Million kwh)		
1975	588,140	403,049	687,680	68,222	1,747,091
1976	606,452	425,094	754,069	69,631	1,855,246
1977	645,239	446,514	786,037	70,571	1,948,361
1978	674,466	461,163	809,078	73,215	2,017,922
1979	682,819	473,307	841,903	73,070	2,071,099
1980	717,495	488,155	815,067	73,732	2,094,449
1981	722,265	514,338	825,743	84,756	2,147,103
1982	729,520	526,397	744,949	85,575	2,086,441
1983	750,948	543,788	775,999	80,219	2,150,955
1984	777,654	578,281	840,588	81,849	2,278,372
1985	790,977	608,968	824,523	85,075	2,309,543
1986	817,663	641,469	808,292	83,409	2,350,835
1987	849,613	673,707	845,266	86,854	2,455,440
1988	892,125	697,711	895,751	82,362	2,567,949
1989	904,449	723,785	914,834	90,715	2,633,833
% chg 89/75	+53.8	+79.6	+33.0	+33.0	+50.8

Source: Energy Information Administration

continuously since 1970. But the increase in prices accelerated the reduction. Energy consumed per unit of GNP fell 29.5% between 1970 and 1989 and is still falling. With low energy costs and a sharp increase in energy consumption, the improvement in efficiency slowed briefly from 1986–88. But it appears to have resumed again. Low energy prices tend to reduce energy consumption efficiency.

The total amount of energy consumed peaked in 1979 at 78,898 trillion BTU. It fell 10.7% to 70,524 trillion BTU in 1983. It was then oscillating up and down for a few years. It moved up to 74,101 trillion BTU in 1984, down to 73,945 trillion BTU in 1985 and then back up to 74,237 trillion BTU in 1986. Energy consumption has been climbing since 1985. It moved up to 76,845 trillion BTU in 1987, 80,200 trillion BTU in 1988, and 81,276 trillion BTU in 1989. It has moved up 15.2% over the four years, 1985–89. However, this was also a period of extended economic growth.

Between 1979 and 1989, GNP increased 29%, while the energy consumed to fuel the increased economic activity moved up only 3%. This is in sharp contrast to the earlier era, 1950–70. Over that span, GNP moved up 100.2% and energy consumption increased 97.5%. At that time there was a one-to-one relationship between economic growth and energy growth. This changed markedly with higher energy costs.

There was a substantial shift in energy market shares for the various fuels, between the year of peak energy consumption, 1979, and 1985. Petroleum's share of the energy market fell from 47.1% in 1979 to 41.8% in 1985. The share from natural gas fell from 26.2% to 24.1%. The lost market share was taken by coal, nuclear and hydroelectric and geothermal energy. Coal energy moved up from 19.1% to 23.6% of the market in 1985. Hydroelectric and geothermal energy moved up from 4.1% to 4.9%, and nuclear power increased from 3.5% to 5.6% of the energy market.

Due to the sharp drop in crude oil prices in 1986, there was a temporary shift in the trend of market shares. Petroleum's share moved up to 43.4%, coal fell to 23.2%, natural gas fell to 22.5%, nuclear moved up to 6.1%, and hydro and others slipped to 4.8%.

Higher crude oil prices changed the competitive mix again in 1987. In that year petroleum dropped slightly to 42.8%. Natural gas moved up to 23%, coal moved up to 23.5%, nuclear moved up again to 6.4% and hydro fell to 4.3%. Although petroleum prices fell again in 1988, market share slipped to 42.7%. Natural gas moved up to 23.1% of the market. Coal stayed at 23.5%, but nuclear jumped to 7.1% of total energy. Due to poor weather conditions hydroelectric and other energy fell to only 3.6%.

In 1989, the energy mix shifted again. Petroleum slipped again to 42.1% of the market, while natural gas moved up again to 23.8%. Hydroelectric, geothermal and other miscellaneous energy managed to recapture a small share of the market, moving up to 3.8%. As a result, coal slipped to 23.3%. Nuclear fell to 7%, the first market share decline for nuclear. Some shutdowns for maintenance slowed the growth in nuclear energy in 1989.

ELECTRICAL ENERGY. The growth in consumption of electrical power has been one of the most consistent and long-term trends in the energy industry. In addition, the portion of total energy used for generating electrical power has been steadily increasing.

In 1947, just after World War II, only 12.9% of total U.S. energy consumption went for generation of electrical power. As the economy grew and changed, this increased substantially. By 1961 it had climbed to 18.8%, and by 1971 it was up to 25.2% and still climbing. It reached 33.5% in 1981 and 35.9 in 1989. Over one-third of all energy consumed is now used for electrical power generation.

This upward trend to a higher percentage of energy for electrical power will continue for the foreseeable future. The economy is shifting to more service- and information-oriented activity and industry is shifting toward more automation. Both of these movements call for energy in the form of electricity.

Net electricity generation at electric utilities has moved up in every year but one since 1973. Net electricity generated in 1973 was 1,860.7 billion kilowatt hours. This has increased 49.2%, to 2,780.8 billion kilowatt hours in 1989. This translates to an average annual growth rate of 2.54% per year over 16 years.

Demand for electricity has gone up in all sectors of the economy. Growth has been greatest in the commercial sector, reflecting the shift to a service economy. Commercial demand has increased 86.4% from 1973 to 1989. Residential demand has increased 56.2% and industrial demand has moved up 33.3%. Electrical energy is produced using all of the basic forms of energy: petroleum, natural gas, coal, hydro, nuclear, geothermal and others.

Coal has been and continues to be the primary fuel source for electrical utilities. In 1973, coal accounted for 43.6% of tne fuel for electrical power generation. This moved up to 54.6% in 1985. Coal lost a portion of its utility market share in 1986, due to the extremely low oil prices, and fell slightly to 54.2%. With the increase in oil prices in 1987, coal moved back up to 55% of the energy for electric utilities. It moved up again to 55.3% in 1988 and 55.8% in 1989.

The level of total coal consumption is mostly dependent upon electric utility demand. Therefore, coal consumption has been rising rather steadily over this period of fluctuating energy demand. Coal consumption moved up from 562.6 million short tons in 1973 to 818 million in 1985, an increase of 45.4%. Consumption reclined slightly in 1986, falling to 804.3 million short tons, down 1.7%. It rebounded in 1987, increasing 4.1% to 836.9 million short tons. With strong electricity demand, it increased 5.6% in 1988, to 883.6

million short tons. It moved up marginally in 1989 0.7%, to 889.5 million short tons.

Coal consumption levels vary with economic activity, but increased consumption by electric utilities has continued to push up demand. Coal consumed by electric utilities increased 783%, from 389.2 million short tons in 1973 to 693.8 million short tons in 1985. The percentage of total coal consumed in electrical power generation increased from 69.2% in 1973 to 84.8% in 1985. Over this period, coal consumed by utilities moved up 305 million short tons. while total coal consumption moved up only 255 million short tons. The long-run growth in coal consumption is obviously dependent upon the growth in electrical power generation.

However, coal does face some potential competition, even in electrical power generation. When oil prices dropped to extremely low levels during mid-1986, coal lost some of its utility market to petroleum. As a result, in 1986, coal consumption by electric utilities fell 8.8 million short tons, to 685.1 million short tons. Total coal consumption fell 13.7 million short tons. Coal consumption by industrial coke plants also fell in 1986, dropping 5.1 million short tons.

Oil prices moved back up in 1987, reducing some of the competitive pressure. Coal consumption by electric utilities increased 4.8%, to 717.9 million short tons. This was an increase of 32.8 million short tons. Total coal consumption moved up 32.6 million short tons. Even though oil prices fell again in 1988, coal consumption moved up on the strength of electric utility demand. Coal consumed by electric utilities increased 5.6% in 1988, increasing 40.5 million short tons to 758.4 million short tons. It increased only 1% in 1989, to 765.8 million short tons. Electric power from hydro facilities was down in 1988, but moved up in 1989. This accounts for the pattern in utility coal consumption.

Nuclear power's share of total electrical power generation has also been rising steadily. The nuclear power share of total energy used for electrical generation increased from 4.6% in 1973 to 19.5% in 1988 and 19% in 1989. Nuclear power growth slowed in 1989 due to maintenance requirements.

The number of operable nuclear reactors increased from 39 at year end 1973 to 110 at the end of 1989 and up to 112 by mid year 1990. The peak capacity defined as "net summer capacity of operable reactors" moved up from 22.615 million net kilowatts in 1973 to 97.869 million net kilowatts at vear end 1989, and 100.169 million net kilowatts in mid 1990. Electricity generated from nuclear facilities increased from 83.5 billion net kilowatt-hours in 1973 to 529 billion net kilowatt-hours in 1989, an increase of 534.1% in electrical power generated.

Although the power generated by nuclear facilities has steadily increased along with the capacity, the utilization rate of the reactors has fluctuated. The percentage of capacity utilized has fluctuated from a low of 47.9% in 1974 to a high of 64.7% in 1978.

After the Three Mile Island incident, the utilization rate decreased. Concerns for safety increased the amount of time the reactors were shut down for maintenance and safety checks. The rate fell to 54.4% in 1983. It was 56.3% in 1984, 58% in 1985 and 56.9% in 1986. It moved up to 57.4% in 1987, 63.5% in 1988 and 62.3% in 1989. The utilization rate was down in 1989 as a number of units were undergoing maintenance.

However, it is felt that there is considerable room for improvement in the utilization rate. Additional power could be generated without new facilities if the utilization rate was increased. This would be a major factor in the future growth of nuclear power. Only a few new units are to be completed in the future.

Hydroelectric power supplied 9.7% of energy for electrical power generation in 1989. This was up from only 9.1% in 1988 Hydroelectric power energy output dropped to 2,639 trillion BTU in 1988, the lowest level in years. The hydro share depends upon weather conditions such as

rainfall and snowfall in certain regional areas. The rainfall and snow melt were very low in 1987 and 1988. Hydropower hit a peak in 1983 at 3,899 trillion BTU. This was 15.5% of the energy for electrical power that year.

The natural gas share of energy consumed for electrical power generation fell from 18.9% in 1973 to 10.1% in 1986. It moved up slightly to 10.7% as it recaptured market share from petroleum in 1987. But it fell again in 1988, dropping to 9.5% and then moved up to 9.7% in 1989. Total natural gas energy consumed for electrical power generation was 3,748 trillion BTU in 1973. It was down to 2,945 trillion BTU in 1989.

The volume of gas consumed by electric utilities fell 29%, from 3,660 billion cu.ft. in 1973 to 2,602 billion cu.ft. in 1986. This decline accounted for 17.5% of the overall drop in natural gas consumption from 1973 to 1986. There was a loss of 442 billion cu.ft. in 1986 as natural gas lost market share in the utility sector to low-cost heavy fuel oil. The volume moved up to 2,844 billion cu.ft. in 1987. Gas prices were more competitive with crude oil prices and gas regained a portion of the utility market. However, consumption in this area fell again in 1988 to 2,636 billion cu.ft. Low heavy fuel oil prices enabled oil to displace some natural gas as it had in 1986. Natural gas consumption for electrical power generation increased to 2,768 billion cu.ft. in 1989.

The share of total natural gas consumed by electric utilities was 16.6% in 1973. It moved up to 18.8% in 1981. At that time, there were concerns about natural gas shortages developing in other sectors of the economy, and government restrictions were placed on natural gas use by utilities. The share fell to 17.3% in 1983, and down to a low 16.0% in 1986. In 1986, competitive pressure from extremely low-cost heavy oil reduced the volume of natural gas consumed by electric utilities. It jumped back up to 17.1% in 1987 when crude oil prices moved higher and gas regained its competitive advantage. The share of gas used for power generation fell sharply in 1988 to 14.6%. Power plants switched to lower-cost heavy fuel oil again in 1988. In 1989, natural gas consumed by power plants increased but the share increased, only marginally to 14.7%.

The largest drop in natural gas consumption was in the industrial sector. Industrial natural gas consumption fell 35.8%, from 8,689 billion cu.ft. in 1973 to 5,579 billion cu.ft. in 1986. This was a drop of 3,110 billion cu.ft. It accounted for 53.3% of the decline in natural gas consumption between 1973 and 1986. Conservation, fuel switching and an economic shift away from heavy industry all contributed to the decline.

With somewhat of a resurgence of industrial activity, consumption of natural gas in the industrial sector moved up in 1987, increasing 316 billion cu.ft., 5.7%. Lower prices for natural gas, higher prices for heavy fuel oil, and more aggressive gas marketing accounted for the increase. The upward swing in gas consumption in industrial activity continued strong in 1988 and 1989. In 1988, it moved up another 7.2%, 430 billion cu.ft., to 6,383 billion cu.ft. In 1989, natural gas consumption in the industrial sector moved up 459 billion cu.ft., an increase of another 7.2%, to 6,842 billion cu.ft.

The petroleum energy share of energy used for electrical power generation fell from 17.7% in 1973 to 4.1% in 1985. Substantially lower heavy fuel oil prices in 1986 stimulated electric utility consumption of petroleum. The petroleum share moved up to 5.5% in 1986 as the energy input from petroleum increased 33.2%. In 1986 the price of heavy residual fuel oil fell to a level that was competitive with natural gas and even coal in electrical power generation. The electric utilities with multi-fuel capability shifted to residual fuel consumption to take advantage of the lower cost.

With higher fuel oil prices in 1987, the share of electrical power from petroleum fell to 4.6%. But lower prices in 1988 boosted the share back up to 5.5%. Even with slightly higher prices for fuel oil, it increased to 5.8% in 1989.

The volume of oil consumed in electrical power generation fell 69%, from 560 million barrels in 1973 to 173 million barrels in 1985. It rebounded to 230 million barrels in 1986 due to lower oil prices. Consumption slipped back in 1987 to 199 million barrels as oil prices rebounded. But prices plummeted again in 1988 and oil consumption by electric utilities jumped up to 248 million barrels. It moved up again in 1989 to 267 million barrels.

The drop in petroleum used for power generation is the major reason for the decline in heavy residual fuel oil consumption. The share of total petroleum consumption used for electrical power generation fell from 8.9% in 1973 to 3.0% in 1985. It moved up to 3.9% in 1986 but slipped to 3.3% in 1987. In bounced back to 3.9% in 1988 as utility consumption of petroleum increased sharply. It climbed again in 1989 to 4.2%.

As the economy continues to shift toward services, information and automation, electrical power demand is expected to continue to increase. The energy sources that provide the fuel for power generation will also continue to grow over the forecast period.

OUTLOOK

The recent dispute in the Middle East between Iraq and Kuwait took a substantial volume of oil off the world market. This has driven up the price of crude oil to levels not seen since 1985, increasing over 50%. And there is a good chance that prices will move even higher during the winter heating season when demand increases.

An increase in the price of oil of this magnitude will have an impact on demand for energy and an impact on economic growth. The longer oil prices stay at this higher level, the more effort it will take for the economy to adjust to the new cost level for energy. Therefore the length of time that prices remain elevated will play a major role in determining demand for energy and the consumption levels of the different types of basic energy.

At this time it is uncertain how long the crisis involving Iraq and Kuwait will last. It is quite probable that the loss of this volume of crude oil will exert upward pressure on crude oil prices as long as the crisis continues. This makes it almost impossible to project with any certainty the most likely trend in investments over the forecast period.

Therefore, in this edition of the Oil Industry Outlook, three scenarios are being presented. The three scenarios vary in expectations of the length of time the crisis in the Persian Gulf will last. The length of time the oil crisis continues will determine the trend in the price of crude oil, the trend in energy consumption and the trend in economic growth. To cover these variations three separate forecasts are presented. The forecast with the highest degree of probability is the one that comes closest to estimating the length of time it takes to finally resolve this issue in the Middle East, and for Iraqi and Kuwaiti oil to return to the market. Following is a brief review of the key points of each scenario. They are discussed in more detail in earlier chapters.

Scenario I—The embargo of oil exported from Iraq and Kuwait continues for a period of 6–18 months. The vast majority of oil production in Iraq and Kuwait is shut in for the duration of the dispute. Oil production capacity in other OPEC areas is not affected by the dispute. Following the settlement of the dispute, production in Iraq and Kuwait is resumed at previous levels.

Scenario II—The embargo of oil exported from Iraq and Kuwait continues for a period of 18–30 months. The vast majority of oil production in Iraq and Kuwait is shut in for the extended duration of the dispute. Oil production capacity in other OPEC areas is not affected by the dispute. Following the settlement of the dispute, production in Iraq and Kuwait is resumed at previous levels.

Scenario III—The embargo of oil exported from Iraq and Kuwait continues for less

than six months. The vast majority of oil production in Iraq and Kuwait is shut in during this period. Production capacity in other OPEC countries is not affected by this dispute. Following settlement of the dispute, production in Iraq and Kuwait is resumed at previous levels.

The major differences between the three scenarios is the length of time that the crisis continues and Iraqi and Kuwaiti oil is off the market. But even though the length of time until settlement of the dispute is the only apparent difference, these three scenarios will cause three distinct sets of conditions in the oil market. And the different market conditions will create differing projections of price, type and level of energy consumption and rate of economic growth over the forecast period, 1991–95.

U.S. economic activity is projected to continue to grow throughout the forecast period but at varying rates of growth during the forecast period and at different rates for the three scenarios. Energy consumption is also expected to move up with the growth rate varying according to the rates of economic growth.

Efforts aimed at improving energy conservation are expected to continue. And the economy is expected to continue its shift toward industries that are less energy-intensive with movement toward the service and information industries, and away from energy-intensive heavy manufacturing industries. The result will be a continued improvement in energy efficiency over the forecast period. The energy consumed per real GNP dollar is expected to decline another 3%–4% by 1995.

Consumption of all forms of basic energy are expected to increase by the end of the forecast period. However, the growth path will be rather erratic for some energy forms due to the sudden escalation in crude prices.

The relative amounts of each type of energy consumed will be influenced a great deal by the increase in electrical power demand. The shift toward a more service-oriented and automated economy will boost demand for electrical power. Electrical power consumption is projected to increase faster than total energy.

The growth in electrical power generation will be fueled mainly by growth in hydropower, coal, and nuclear energy during the earlier years of the forecast period.

Nuclear power generation is projected to move up at a slower pace than in the past years. It is projected to peak in 1993, due to the safety concerns that have prevented the construction of additional capacity. No new nuclear plants are being planned.Therefore when existing construction is completed, major growth in nuclear power will come to a halt. Nuclear plant capacity will not be increased after 1993, but there could be increased energy from an improvement in the utilization rate of nuclear capacity.However, in all three scenarios nuclear power generation is projected to peak in 1993. Increased capacity utilization in some facilities will be offset by downtime in others for maintenance and safety checks.

The extent of growth in nuclear power generation beyond the forecast period is in doubt. Long range growth of nuclear power has become more of a political and environmental issue than an economic decision. Concerns about the safety of nuclear facilities has almost halted the growth in nuclear capacity beyond the forecast period. With lead times of 10 years or more for planning and construction of new facilities, increased capacity can not be expected in the foreseeable future. Any additional output can be obtained only if plant efficiency improves and the utilization rate of existing facilities moves up.

With the increase in electrical power demand, coal consumption will also increase over the forecast period. The one issue that may cloud the longer-range outlook for the increase in coal consumption is concern about the environment. If environmental concerns about acid rain and clean air end up adding a lot to the cost of consuming coal, it could lose some of its competitive price advantage over petroleum and natural gas. In that

case, the growth of coal consumption would be slowed. This forecast assumes that coal will be able to maintain its competitive advantage. However, this is an area of major concern and could greatly influence future trends.

Hydroelectric power generation is expected to move up substantially from the depressed levels of 1988 and 1989. Hydropower is dependent upon weather conditions. A return to more normal, wetter weather, and a buildup of the reservoirs will boost hydro output. Hydropower is projected to move up close to existing capacity during the forecast period.

Lower oil and natural gas prices could make these fuels more competitive in the electrical power generation market. While oil prices are elevated, utilities will probably shift to other energy sources. Oil and natural gas are not expected to make a great deal of headway until the growth in nuclear generation slows and coal consumption becomes a major environmental issue.

Later in the forecast period an energy gap may develop that will have to be filled by increased natural gas or petroleum consumption. Nuclear energy growth is expected to come to a halt in 1993. Hydropower will also be near capacity. Energy from coal may also be constrained due to environmental concerns. Therefore energy from these fuel sources will not be sufficient to meet the total energy requirements for electrical power generation.

A recent survey of utility capacity construction plans confirms these expectations. Of 80 power units in the planning stages, 62 are being planned to burn natural gas and/or oil. Only seven are slated to burn coal in baseload steam plants.

Over most of the forecast period the growth in demand for petroleum energy is expected mainly in economic sectors where it has an advantage as a liquid transport fuel. And in industrial sectors such as petrochemicals, where it is an important feedstock.

Natural gas will be the major swing fuel over the forecast period 1991–95. The level of demand for natural gas will depend upon the rate of economic growth, and growth in energy demand. Slower economic growth will result in lower energy demand and lower demand for natural gas. In the scenarios with more rapid economic growth, natural gas will gain energy market share toward the end of the forecast period.

SCENARIO I—Oil prices will remain high through 1991. After the dispute in the Middle East is settled and the lost oil is back in the market, oil prices will fall. With continued economic growth and increased energy demand, oil prices will move up gradually over the remainder of the forecast period.

The higher oil prices in 1991 will slow economic growth and slow energy demand. Energy consumption is projected to move up only 0.8%, to 82.01 quadrillion BTU. Demand for natural gas is expected to slip due to the slow growth in economic activity and energy demand. Energy from natural gas will slip 0.4%, to 19.175 quads.

When oil prices fall in 1992, this will give a boost to economic growth and increase energy demand. Energy consumption is projected to move up 2.1% in 1992. Relatively low energy prices over the remainder of the forecast period will help boost economic growth and energy consumption. At the end of the forecast period, 1995, energy consumption will be up 8.6%. Electrical power generation will be up 11.8% in 1995. The slowdown in growth of electrical power generation from hydroelectric facilities, and the peaking of nuclear power output in 1993, will result in increased demand for natural gas later in the forecast period.

SCENARIO II—Oil prices will remain high through 1991 and 1992. After the dispute in the Middle East is settled and the Iraqi and Kuwaiti oil is back in the market, oil prices will fall. With continued economic growth and increased energy demand, oil prices will move up gradually over the remainder of the forecast period.

The higher oil prices in 1991 and 1992

will slow economic growth and slow energy demand. Energy consumption is projected to move up only 0.8%, to 82.01 quadrillion BTU in 1991. Demand for natural gas is expected to slip due to the slow growth in economic activity and energy demand. Energy from natural gas will slip 0.4%, to 19.175 quads.

The slow growth in energy demand will continue through 1992 and energy consumption will move up a modest 0.7%, to 82.58 quads. Growth will continue in energy from coal, nuclear and hydroelectric facilities. Natural gas energy consumption will fall an additional 1.6% to 18.86 quads.

When oil prices fall in 1993, this will give a boost to economic growth and increase energy demand. Energy consumption is projected to move up 4.7% in 1993. Relatively low energy prices over the remainder of the forecast period will help boost economic growth and energy consumption. At the end of the forecast period, 1995, the level of energy consumption will be up 7.2% from 1990. Electrical power generation will be up 10.1% in 1995. The slowdown in growth of electrical power generation from hydroelectric facilities, and the peaking of nuclear power output in 1993, will result in increased demand for natural gas later in the forecast period.

SCENARIO III—Oil prices will remain high only through 1990 and possibly into early 1991. After the dispute in the Middle East is settled and the lost oil is back in the market, oil prices will fall. Oil prices are expected to move up gradually over the rest of the forecast period.

The higher oil prices will slow economic growth and energy demand only marginally. The lower prices will then boost economic activity and energy demand later in 1991. Energy consumption is projected to move up 1.5%, to 82.91 quadrillion BTU. Demand for natural gas is expected to continue to move up due to the stronger growth in economic activity and energy demand. Energy from natural gas will increase 1.7% in 1991 to 19.62 quads.

Relatively low energy prices over the forecast period will help boost economic growth and energy consumption. At the end of the forecast period, 1995, energy consumption will be up 9.8%. Electrical power generation will be up 12% in 1995. The slowdown in growth of electrical power generation from hydroelectric facilities, and the peaking of nuclear power output in 1993, will result in increased demand for natural gas. Demand for natural gas energy will be up 13.3% in 1995.

It should be noted that beyond the forecast period, providing adequate electrical power to meet the growing demand for electricity may become a serious problem. The major sources of energy for electrical power generation are coal and nuclear power and to a lesser extent hydropower. The first two of these energy sources are under attack from groups concerned about nuclear power dangers and potential environmental pollution. And hydropower has limited capacity. What could develop in the future is a surge in demand for natural gas and possibly even petroleum for electrical power generation.

OTHER ENERGY SOURCES KEYS TO THE FUTURE SCENARIO I

1. Economic activity will continue to grow throughout the forecast period. However, the growth in economic activity will be slowed in 1991 due to the substantially higher oil and energy prices. The rate of growth will increase in 1992 after oil prices fall.

2. Energy consumption will move with the growth in economic activity. Total U.S. energy consumption will increase throughout the forecast period. However, the growth in energy consumption will be slowed in 1991 due to slower economic growth. Energy consumption growth will accelerate in 1992 when prices fall. It will continue to move up over the remainder of the period.

3. The shift toward less energy-intensive industries will continue. The U.S. economy will become more service- and information-oriented. This will result in a growing demand for electrical power which is projected to be up 11.8% by 1995.

4. The generation of electrical energy from nuclear power will reach a peak in 1993, since no new capacity will be added. After that, any growth will be due to an improvement in the rate of capacity utilization.

5. Hydropower energy will rebound and move back toward capacity. This will supply some of the growth in energy required for additional electrical power generation.

6. Coal consumption will increase 10.4% over the forecast period. The increase will be due to the increase in electrical power demand. Coal consumption could run into some environmental problems during the forecast period.

7. Natural gas energy consumption will fall in 1991 due to the slowdown in the growth of energy demand. However, demand will move up over the remainder of the forecast period. The peaking of power output from nuclear facilities and environmental concerns about coal should result in more demand for natural gas. Annual natural gas energy consumption will be up 9.5% in 1995 at the end of the forecast period.

THE OUTLOOK—OTHER ENERGY SOURCES
SCENARIO — I

	1989	1990	1991	1992	1993	1994	1995	Change 1990 to 1995	% change 1990 to 1995
ENERGY DEMAND									
(trillion BTU)									
Petroleum	34,025	33,740	33,935	34,580	35,130	35,590	36,050	+2,310	+ 6.8
Natural gas	19,506	19,250	19,175	19,600	20,160	20,600	21,080	+1,830	+ 9.5
Coal	18,916	19,030	19,340	19,650	20,100	20,600	21,000	+1,970	+10.4
Nuclear	5,687	5,960	6,060	6,150	6,200	6,200	6,200	+240	+ 4.0
Hydro and other	3,106	3,380	3,500	3,750	3,900	3,950	4,000	+620	+18.3
Total energy demand	**81,240**	**81,360**	**82,010**	**83,730**	**85,490**	**86,940**	**88,330**	**+6,970**	**+ 8.6**
Coal consumption									
(million short tons)	889	895	910	925	945	965	985	+90	+10.1
Electricity generation									
(billion kilowatthours)	2,781	2,840	2,900	2,970	3,050	3,120	3,175	+335	+11.8
Nuclear capacity									
(million kilowatts)	98	100	101	102	103	103	103	+3	+ 3.0
Nuclear generation									
(billion kilowatthours)	529	555	565	575	580	580	580	+25	+ 4.5

OTHER ENERGY SOURCES KEYS TO THE FUTURE SCENARIO II

1. Economic activity will continue to grow throughout the forecast period. However, the growth in economic activity will be slowed in 1991 and 1992 due to the substantially higher oil and energy prices. The rate of growth will increase in 1993 after oil prices fall.

2. Energy consumption will move with the growth in economic activity. Total U.S. energy consumption will increase throughout the forecast period. However, the growth in energy consumption will be slowed in 1991 and 1992 due to slower economic growth. Energy consumption growth will accelerate in 1993 when prices fall. It will continue to move up over the remainder of the period.

3. The shift toward less energy-intensive industries will continue. The U.S. economy will become more service- and information-oriented. This will result in a growing demand for electrical power, which is projected to be up 11.3% by 1995.

4. The generation of electrical energy from nuclear power will reach a peak in 1993, since no new capacity will be added. After that, any growth will be due to an improvement in the rate of capacity utilization.

5. Hydropower energy will rebound and move back toward capacity. This will supply some of the growth in energy required for additional electrical power generation.

6. Coal consumption will increase 10.4% over the forecast period. The increase will be due to the increase in electrical power demand. Coal consumption could run into some environmental problems during the forecast period.

7. Natural gas energy consumption will fall in 1991 and 1992 due to the slowdown in the growth of energy demand. However, demand will move up over the remainder of the forecast period. The peaking of power output from nuclear facilities and environmental concerns about coal should result in more demand for natural gas. Annual natural gas energy consumption will be up 5.2% in 1995 at the end of the forecast period.

THE OUTLOOK—OTHER ENERGY SOURCES
SCENARIO — II

	1989	1990	1991	1992	1993	1994	1995	Change 1990 to 1995	% change 1990 to 1995
ENERGY DEMAND									
(trillion BTU)									
Petroleum	34,025	33,740	33,935	34,170	34,760	35,250	35,740	+2,000	+ 5.9
Natural gas	19,506	19,250	19,175	18,860	19,440	19,830	20,260	+1,010	+ 5.2
Coal	18,916	19,030	19,340	19,650	20,100	20,600	21,000	+1,970	+10.4
Nuclear	5,687	5,960	6,060	6,150	6,200	6,200	6,200	+240	+ 4.0
Hydro and other	3,106	3,380	3,500	3,750	3,900	3,950	4,000	+620	+18.3
Total energy demand	**81,240**	**81,360**	**82,010**	**82,580**	**84,400**	**85,830**	**87,200**	**+5,840**	**+ 7.2**
Coal consumption									
(million short tons)	889	895	910	925	945	965	985	+90	+10.1
Electricity generation									
(billion kilowatthours)	2,781	2,840	2,900	2,960	3,035	3,100	3,160	+320	+11.3
Nuclear capacity									
(million kilowatts)	98	100	101	102	103	103	103	+3	+ 3.0
Nuclear generation									
(billion kilowatthours)	529	555	565	575	580	580	580	+25	+ 4.5

OTHER ENERGY SOURCES KEYS TO THE FUTURE SCENARIO III

1. Economic activity will continue to grow throughout the forecast period. The growth in economic activity will be slowed marginally in 1991 due to the substantially higher oil and energy prices. The rate of growth will increase in the latter part of 1991 after oil prices fall.

2. Energy consumption will move with the growth in economic activity. Total U.S. energy consumption will increase throughout the forecast period. Energy consumption growth will accelerate in 1991 when prices fall. It will continue to move up over the remainder of the period.

3. The shift toward less energy-intensive industries will continue. The U.S. economy will become more service- and information-oriented. This will result in a growing demand for electrical power, which is projected to be up 12% by 1995.

4. The generation of electrical energy from nuclear power will reach a peak in 1993, since no new capacity will be added. After that, any growth will be due to an improvement in the rate of capacity utilization.

5. Hydropower energy will rebound and move back toward capacity. This will supply some of the growth in energy required for additional electrical power generation.

6. Coal consumption will increase 9.9% over the forecast period. The increase will be due to the increase in electrical power demand. Coal consumption could run into some environmental problems during the forecast period.

7. Natural gas energy consumption will move up in 1991 due to the increase in the growth of energy demand. Demand will move up over the remainder of the forecast period. The peaking of power output from nuclear facilities and environmental concerns about coal should result in more demand for natural gas. Annual natural gas energy consumption will be up 13.3% in 1995 at the end of the forecast period.

THE OUTLOOK—OTHER ENERGY SOURCES
SCENARIO — III

	1989	1990	1991	1992	1993	1994	1995	Change 1990 to 1995	% change 1990 to 1995
ENERGY DEMAND									
(trillion BTU)									
Petroleum	34,025	33,940	34,380	35,065	35,595	36,085	36,595	+2,655	+ 7.8
Natural gas	19,506	19,300	19,620	20,205	20,805	21,325	21,865	+2,565	+13.3
Coal	18,916	19,110	19,350	19,650	20,100	20,600	21,000	+1,890	+ 9.9
Nuclear	5,687	5,960	6,060	6,150	6,200	6,200	6,200	+240	+ 4.0
Hydro and other	3,106	3,380	3,500	3,750	3,900	3,950	4,000	+620	+18.3
Total energy demand	**81,240**	**81,690**	**82,910**	**84,820**	**86,600**	**88,160**	**89,660**	**+7,970**	**+ 9.8**
Coal consumption (million short tons)	889	898	910	925	945	965	985	+87	+ 9.7
Electricity generation (billion kilowatthours)	2,781	2,849	2,905	2,980	3,055	3,125	3,190	+341	+12.0
Nuclear capacity (million kilowatts)	98	100	101	102	103	103	103	+3	+ 3.0
Nuclear generation (billion kilowatthours)	529	555	565	575	580	580	580	+25	+ 4.5

OPEC

The invasion of Kuwait by Iraq involves two OPEC members in violent conflict. This follows on the heels of the long Iran-Iraq war, also between two OPEC countries. OPEC managed to stay intact through the Iran-Iraq war, but there is some doubt that it will be able to survive with the same group of countries through and after this conflict.

Several OPEC members besides Kuwait have chosen to

align with the forces opposing Iraq. The need for security has taken precedent over ethnic or religious ties. Saudi Arabia and theUnited Arab Emirates in particular have felt it necessary toembrace the placing of outside forces in the region to thwart thepossible aggression by Iraq. And other OPEC members have beenasked to support the U.N. resolutions requiring an embargo on allexports and imports by Iraq.

Several of the OPEC members did take sides in the war between Iran and Iraq but most of the aid was in the form of loans or financial assistance. The war was considered as a dispute between two longstanding enemies. In addition, forces outside of the region did not get involved in a major way. Therefore this conflict may be more wearing on the fabric that has held OPEC together.

It is difficult to predict whether the OPEC countries will stay together and the present structure will remain through and after the resolution of the conflict. Obviously, if Iraq does not leave Kuwait, one of the participating OPEC countries will have been eliminated. But even if Iraq does leave Kuwait, there may be changes in the OPEC structure or it may disintegrate and some other alliance may be created.

The invasion of Kuwait has undoubtedly made some of the OPEC countries uneasy about their security. This may result in the other vulnerable OPEC states, such as Saudi Arabia, the UAE and Qatar, forging some form of trade alliance with Western industrial petroleum-consuming countries. These trade alliances could also contain clauses or defense pacts that would provide some military security for these OPEC countries. This would tend to pry these countries away from the OPEC cartel.

OPEC was already splitting into groups with differing interests. A few of the OPEC countries have huge crude oil reserves that would last for many years at current rates of production. It is generally in the best interests of these countries to keep oil price growth moderate and to try to stimulate consumption. They do not want prices to escalate to a level that would instead stimulate conservation and investment in alternative fuels.

The other OPEC countries with smaller reserves generally wish to maximize their current revenues from oil exports. They would prefer to see higher oil prices immediately. Their reserves will not last very long and they prefer to have current revenue for investment in diversification away from oil.

OPEC has had many problems within the organization with respect to determining a level of production and prices that will satisfy all of the 13 member countries. The internal struggles have led to constantly changing policies and actions by OPEC. And this has kept the worldwide oil and gas industry in a state of turmoil for the past 10–15 years.

It is obvious that the economic interests of these two groups do not coincide. Therefore there may be a split at some time over these differences. However, these countries have experienced some success with influencing the oil market via a cartel. And the major oil-exporting countries may band together within some new group dedicated to controlling the worldwide oil market.

It is uncertain as to whether OPEC will have the same type of influence over the oil market during the forecast period, 1991–95, as they have had over the past 15 years. Prior to the invasion it was felt that OPEC's influence was once again on the rise. Worldwide demand for oil products was increasing. Most of the increase in demand was being supplied by the OPEC countries.

And the surplus production capacity that was exerting downward pressure on prices was diminishing. This would put OPEC in a position to exercise much more control over crude prices. In particular they would be able to force prices much higher by controlling production volumes.

And this would give them influence over other elements in the energy industry. The price of oil has an impact upon and connection to the price of other competing forms of energy. So OPEC's decisions influence the level of activity in the oil and gas industry and in other energy industries as well.

It is uncertain what OPEC will look like when the sand clears and the Iraq-Kuwait dispute is

settled. However, it is worthwhile to keep a close eye on their activities in order to have a better understanding of changes in the industry.

This section takes a close look at OPEC and the many changes that have taken place in the industry in the past due to OPEC actions. It also looks closely at the reasons why OPEC has had considerable influence over the oil market. And it also points out why OPEC has had problems with controlling the market.

THE OPEC ORGANIZATION. OPEC was formed in 1960 with the original participating countries being Iran, Iraq, Kuwait, Saudi Arabia and Venezuela. It has since grown to include 13 countries.

The 13 member countries and the year they joined OPEC are listed below:

1960
Iran
Saudi Arabia
Iraq
Venezuela
Kuwait
1961
Qata
1962
Indonesia
Libya
1967
Algeria
Abu Dhabi (now part of UAE)
1971
Nigeria
1973
Ecuador
Gabon
1974
United Arab Emirates:
Abu Dhabi
Ras al Khaymah
Dubai
Sharjah

OPEC GAS PRODUCTION

1989

Country	Gross	Marketed	Reinjected	Flared	Other losses
			(Billion cu ft)		
Algeria	4,225	1,709	2,106	216	194
Ecuador	25	3	2	20	0
Gabon	77	3	11	61	2
Indonesia	1,942	1,425	318	152	37
Iran	1,540	784	636	53	67
Iraq	406	215	0	172	18
Kuwait	392	288	4	39	61
Libya	487	212	141	118	16
Nigeria	844	166	64	614	0
Qatar	238	215	0	0	23
Saudi Arabia	1,632	1,052	88	138	353
United Arab Emirates	1,035	776	124	40	95
Venezuela	1,370	690	456	127	97
Total OPEC	**14,213**	**7,539**	**3,948**	**1,761**	**965**
% of Total OPEC	**100.0**	**53.0**	**27.8**	**12.4**	**6.8**
Total World	**86,783**	**71,685**	**7,712**	**3,454**	**3,933**
% of Total World	**100.0**	**82.6**	**8.9**	**4.0**	**4.5**

Source: Cedigaz

OPEC TOTAL LIQUIDS PRODUCTION (CRUDE OIL, CONDENSATE, NGL)

Country	1979	1982	1985	1988	1989
			(000 b/d)		
Algeria	1,255	1,045	1,095	1,090	1,170
Ecuador	215	200	275	305	285
Gabon	205	155	155	175	220
Indonesia	1,590	1,415	1,335	1,325	1,395
Iran	3,175	2,410	2,215	2,265	2,865
Iraq	3,475	1,010	1,440	2,600	2,825
Kuwait	2,270	705	920	1,340	1,600
Libya	2,090	1,135	1,105	1,055	1,145
(Neutral Zone)	570	315	340	320	400
Nigeria	2,300	1,285	1,475	1,365	1,605
Qatar	510	340	340	355	395
Saudi Arabia	9,555	6,695	3,565	5,255	5,260
United Arab Emirates	1,835	1,250	1,350	1,775	2,070
Venezuela	2,425	1,965	1,730	1,920	1,980
Total OPEC	**31,470**	**19,925**	**17,340**	**21,145**	**23,215**
Total OECD & LDCs*	**51,275**	**42,080**	**42,580**	**46,405**	**47,885**
Total World	**65,780**	**57,055**	**57,710**	**62,350**	**63,560**
OPEC SHARE:					
% of OECD & LDCs	**61.4**	**47.4**	**40.7**	**45.6**	**48.5**
% Total World	**47.8**	**34.9**	**30.0**	**33.9**	**36.5**

*Organization for Economic Cooperation and Development; and lesser developed countries.

Source: British Petroleum

From time to time OPEC has made overtures to other petroleum-exporting countries, to determine if they have an interest in joining with the cartel. But the OPEC cartel has remained at a group of 13 since 1974. Some of the other major

OPEC RESERVES
CRUDE OIL

Country	1979	1982	Jan. 1 1985 (Million bbl)	1988	1989	1990
Saudi Arabia	165,700	164,600	169,000	166,980	169,970	254,959
Iraq	32,100	29,700	44,500	100,000	100,000	100,000
United Arab Emirates	31,316	32,176	32,490	98,105	98,105	98,105
Iran	59,000	57,000	48,500	92,850	92,850	92,860
Kuwait	66,200	64,480	90,000	91,920	91,920	94,525
Venezuela	18,000	20,300	25,845	56,300	58,084	58,504
Libya	24,300	22,600	21,100	21,000	22,000	22,800
Nigeria	18,200	16,500	16,650	15,980	16,000	16,000
Algeria	6,300	8,080	9,000	8,500	8,400	9,200
Indonesia	10,200	9,800	8,650	8,400	8,250	8,200
(Neutral Zone)	6,480	6,500	5,420	5,210	5,210	5,200
Qatar	4,000	3,434	3,350	3,150	3,150	4,500
Ecuador	1,170	850	1,400	1,615	1,350	1,514
Gabon	1,970	480	510	645	720	733
Total OPEC	**444,936**	**436,500**	**476,415**	**670,655**	**676,009**	**767,100**
Non-OPEC Countries	**102,672**	**148,364**	**138,152**	**137,493**	**147,634**	**150,372**
Total Non-Communist	**547,608**	**584,864**	**614,567**	**808,148**	**823,643**	**917,472**
Total World	**641,608**	**670,709**	**698,667**	**887,348**	**907,443**	**1,001,572**
OPEC SHARE:						
% Non-Communist	**81.3**	**74.6**	**77.5**	**83.0**	**82.1**	**83.6**
% World	**69.3**	**65.1**	**68.2**	**75.6**	**74.5**	**76.6**

Source: Oil & Gas Journal

exporting countries are Mexico, Norway, Angola, Egypt and the United Kingdom.

PRODUCTION. From its inception, OPEC increased its production steadily and rapidly. OPEC production statistics were first tabulated in 1961, and output was 9.364 million b/d. At the start the OPEC countries accounted for 41.8% of total world production and 50.1% of non-communist production. With the addition of new countries and increased demand for oil, output moved up rapidly to 30.989 million b/d in 1973. In that year OPEC output was 55.5% of world production and 67.5% of non-communist world production. This was also at the time that OPEC first pushed up the price of crude oil.

In 1975, OPEC output dropped to 27.155 million b/d, due to the demand response to the higher oil prices and an economic recession in some of the industrial countries. With renewed worldwide economic growth and demand for oil, OPEC production rebounded to 31.298 million b/d in 1977. This was just before the large price hikes that took place in the years 1979–81. OPEC output stayed at close to this level for the next few years and was at 30.928 million b/d in 1979. At this point OPEC started sharply raising crude oil prices.

The sharp increase in prices that took place had a substantial impact on product demand. Conservation, fuel switching, and economic stagnation all worked together to reduce demand for petroleum products. The drop in demand and increased competition from non-OPEC production combined to have a major impact on demand for OPEC oil.

Production fell steadily and reached a recent low of 16.039 million b/d in 1985. This was a drop of 48.1%, 14.889 million b/d, from 1979. In 1985, OPEC production represented only 29.9% of total world output and 42.4% of non-communist production. The aggressive pricing policy adopted by OPEC had made it the swing producer or crude supplier of last resort for the consuming countries.

Consumers invested in conservation equipment or adopted conservation measures to reduce energy and oil consumption. Where possi-

OPEC RESERVES
NATURAL GAS

Country	Jan. 1 1978	Jan. 1 1983 (Billion cu ft)	Jan. 1 1989	Jan. 1 1990	Gross production 1989 (Bcf)	Production/ Reserves (Years)
Saudi Arabia	85,000	117,000	145,848	181,347	1,632	111
Iraq	28,000	28,800	95,000	95,000	406	234
United Arab Emirates	21,500	28,580	201,515	200,800	1,035	194
Iran	500,000	482,600	494,400	500,000	1,540	325
Kuwait	31,500	29,900	42,500	48,600	392	124
Venezuela	41,000	54,079	102,243	100,846	1,370	74
Libya	25,700	21,500	25,700	25,500	487	52
Nigeria	43,000	32,400	85,000	87,400	844	104
Algeria	125,000	111,250	104,200	114,000	4,225	27
Indonesia	24,000	29,600	83,590	87,015	1,942	45
(Neutral Zone)	5,000	8,380	12,300	12,000	—	—
Qatar	40,000	62,000	156,700	163,100	238	685
Ecuador	5,000	4,100	4,020	3,990	25	160
Gabon	2,450	485	600	560	77	7
Total OPEC	**977,150**	**1,010,674**	**1,553,616**	**1,620,158**	**14,213**	**114**
Non-OPEC Countries	**587,509**	**754,053**	**841,025**	**805,661**	**41,419**	**19**
Total Non-Communist	**1,564,659**	**1,764,727**	**2,394,641**	**2,425,819**	**55,632**	**44**
Total World	**2,519,659**	**3,023,527**	**3,955,341**	**3,989,119**	**86,783**	**46**
OPEC SHARE:						
% Non-Communist	**62.5**	**57.3**	**64.9**	**66.8**		
% World	**38.8**	**33.4**	**39.3**	**40.6**		

ble, consumers also switched to other cheaper fuel sources. This substantially reduced the demand for crude oil and most of the reduction was in demand for OPEC oil.

In addition, the high prices stimulated exploration and production elsewhere in the world. This enabled some countries to replace costly OPEC imports. It also resulted in the development of competing export countries. These countries could profitably undercut OPEC prices and capture OPEC market share. As a result, consuming importing countries only called upon expensive OPEC crude oil to fill the gap between the required imports to fuel economic growth, and imports from cheaper non-OPEC sources.

When OPEC production fell, it left behind a substantial volume of excess crude oil production capacity in a number of the OPEC countries. The excess capacity created an element of competition between OPEC member countries. Coupled with competition from increasing non-OPEC production, this put downward pressure on prices.

Prices slid gradually after hitting a peak in 1981 and 1982. The slow price slide continued through 1983, 1984 and 1985. OPEC adopted a quota system in 1983 in an attempt to prop up prices and stop the slide. Due mainly to the production cuts by Saudi Arabia, this restraint on production prevented a rapid deterioration of prices during this period.

However, in 1985 Saudi Arabia grew tired of unilaterally propping up prices. Because the other OPEC countries did not cooperate, the Saudis were required to make massive production cuts to prevent a decline in prices. Saudi Arabia decided on a new policy and set out to secure an acceptable portion of the market. They adopted a net-back pricing system and locked in several crude customers to insure adequate exports. Later that year all of the members of OPEC met and adopted a similar scheme to pursue market share. At the start of 1986 OPEC as a whole attempted to regain some of their lost market share through price competition. The result was an extended period of overproduction and a collapse in prices. OPEC production did move up to 18.074 million b/d in 1986. But there was a substantial loss of

OPEC-PRODUCTION CAPACITY

Country	Production Capacity	Production Av. 1989	Excess capacity	% utilization
	(000 b/d)			
Algeria	900	714	186	79.3
Ecuador	300	279	21	93.0
Gabon	250	211	39	84.4
Indonesia	1,300	1,235	65	95.0
Iran	3,600	2,947	653	81.9
Iraq	3,500	2,897	603	82.8
Kuwait	2,200	1,593	607	72.4
Libya	1,600	1,130	470	70.6
(Neutral Zone)	600	397	203	66.2
Nigeria	1,850	1,672	178	90.4
Qatar	600	387	213	64.5
Saudi Arabia	7,500	4,995	2,505	66.6
United Arab Emirates	2,300	1,866	434	81.1
Venezuela	2,500	1,725	775	69.0
Total OPEC	**29,000**	**22,048**	**6,952**	**76.0**

OPEC PETROLEUM PRODUCT PRODUCTION — CONSUMPTION — EXPORT 1988

	Refinery production	Domestic consumption	Exports
	(1,000 b/d)		
Algeria	440.0	165.1	435.0
Ecuador	112.2	68.5	25.9
Gabon	11.9	7.4	3.0
Indonesia	607.5	511.6	202.3
Iran	548.5	766.0	8.0
Iraq	396.3	289.7	75.0
Kuwait	653.1	95.7	635.0
Libya	255.6	109.9	90.0
(Neutral Zone)	—	—	—
Nigeria	137.5	205.6	21.0
Qatar	38.8	12.6	35.0
Saudi Arabia	1,521.3	666.8	900.0
United Arab Emirates	178.7	112.7	117.0
Venezuela	923.7	382.2	639.0
Total OPEC	**5,825.1**	**3,393.8**	**3,186.2**

Source: OPEC Statistical Bulletin

revenue since the price decline was far greater than the increase in production.

OPEC abandoned the market share objective in late 1986 and returned to production quotas as a means of trying to stabilize the market at an acceptable price. OPEC adopted new production quotas in September 1986 and prices began to firm at a slightly higher level. But prices firmed at a level about 30% lower than 1985 and 50% below the peak years.

As a result of the increase in prices, demand for OPEC oil fell again and OPEC production dropped to 18.584 million b/d in 1987. In 1988, competition developed again among the OPEC countries with excess capacity. That year a number of the countries exceeded the quotas and pushed excess crude onto the market. As a result, prices fell sharply again in 1988. OPEC output moved up to an estimated 19.657. But again, for OPEC as a whole, substantial revenue was sacrificed for market share. However, individual countries may have increased production sufficiently to gain in revenue. The countries that were hurt the most were those without a large level of excess capacity and that therefore could not boost production.

In 1989, increased demand for oil helped boost OPEC production. Prices remained relatively firm throughout the year and total output still moved up, averaging 22.048 million b/d. This was the highest average annual production rate for OPEC since 1981. Producing over quota continued to be an OPEC problem in 1990. During the first half of the year this excess output weakened prices substantially. Refiners added to their stock levels and OPEC production for the first half increased to 23.944 million b/d.

At this time it is hard to determine what the increase in prices will do to the demand for OPEC oil. Therefore it is difficult to predict the production level for the remainder of 1990. Kuwait and Iraq together had averaged production of 4.909 million b/d during first half 1990. Some of the other OPEC countries have vowed to try to make up some of this lost production from their excess capacity. It is too early to tell what portion of the lost oil will be returned to the market. It does not appear that the remaining OPEC countries have sufficient capacity to meet the expected demand for OPEC oil in the latter months of 1990. If this is the case, oil prices could be pushed up much higher than they are now.

OPEC EXCESS CAPACITY. The major reason why OPEC has had such difficulty with controlling world prices is the massive excess crude oil production capacity in the member countries.

The capacity exists because it was developed to satisfy growing world demand for crude oil. Worldwide demand for petroleum was on a steady upward trend throughout the 1950s, 1960s

and 1970s. In general, the growth in worldwide economic activity was being fueled by petroleum— low-cost petroleum. The international oil companies controlled most of the world crude oil import/export trade. The huge oil reserves they found, mostly in the OPEC countries, enabled them to increase output at a pace to satisfy the increase in world demand. They increased output capacity in line with their projections of growth in demand. They generally operated at a sustainable capacity level of 90–95% of installed developed capacity. This left a small excess capacity for contingencies and for maintenance downtime.

When the OPEC countries finally took control of most of their own production, the total OPEC installed capacity was over 30 million b/d and climbing. The sharp escalation in prices that took place in the 1970s and into the early 1980s brought about a reduction in demand for petroleum. As a result, the gap between available capacity and production grew rapidly. This new excess capacity was readily available developed capacity that could be utilized without resorting to costly investment.

The worldwide excess capacity grew to 10–15 million b/d during the 1983–86 period, with the vast majority of the excess in OPEC countries. And in 1989 the excess capacity was still estimated at close to 10 million b/d. This represents excess capacity of over 20% of free world demand for crude oil.

Since the time OPEC production was over 30 million b/d some capacity has been eliminated due to the Iran-Iraq war and to long periods of inactivity. However, it is felt that even a portion of this capacity can be brought back on stream with-some investment. And the huge reserves in some of the OPEC countries could easily be exploited if a major exploration effort was launched. Thus, additional capacity might be readily available within a relatively short time.

This overhanging excess capacity made it easy for individual OPEC countries to increase output if they saw an opportunity to increase their market share. This has resulted in periodic "cheating" on quotas and competition within OPEC, which has helped maintain continuous downward pressure on prices. This downward pressure would have remained until increasing demand eliminated a sufficient portion of the excess capacity.

The invasion of Kuwait by Iraq has accomplished this by eliminating the combined production capacity of these two countries. Iraq's capacity is estimated at 3.5 million b/d and Kuwait's at 2.2 million b/d, for a combined total of 7.7 million b/d. Elimination of this capacity goes a long way toward eliminating the OPEC and worldwide excess capacity.

OPEC QUOTAS AND THE PRICE LEVEL. In 1983, OPEC recognized that the only way they could prevent a rapid slide in prices was to restrict production. They recognized that by balancing world supply and

OPEC-CRUDE EXPORTS

Country	1979	1983	1988	Volume change 1988/79	% change 1988/79
	(000 b/d)				
Algeria	960.4	260.4	168.0	−792.4	−82.5
Ecuador	122.6	126.3	149.8	27.2	22.2
Gabon	164.8	136.4	145.6	−19.2	−11.7
Indonesia	1,077.7	858.3	609.2	−468.5	−43.5
Iran	2,407.0	1,718.7	1,696.0	−711.0	−29.5
Iraq	3,275.3	725.4	2,095.0	−1,180.3	−36.0
Kuwait	2,083.1	544.4	698.0	−1,385.1	−66.5
Libya	1,966.0	937.4	890.0	−1,076.0	−54.7
(Neutral Zone)					
Nigeria	2,210.1	935.2	1,110.5	−1,099.6	−49.8
Qatar	494.9	268.3	304.0	−190.9	−38.6
Saudi Arabia	8,817.7	3,920.8	3,354.8	−5,462.9	−62.0
United Arab Emirates	1,805.3	1,077.3	1,345.0	−460.3	−25.5
Venezuela	1,408.3	976.7	1,011.0	−397.3	−28.2
Total OPEC	**26,793.2**	**12,485.6**	**13,576.9**	**−13,216.3**	**−49.3**

Source: OPEC Statistical Bulletin.

PRICES — DEMAND — OPEC PRODUCTION

	1975	1979	1983	1987	1989
Crude oil price — Saudi Light ($/bbl)	12.35	24.00	34.00	17.53	16.18
OECD & LDCs* product demand (000 b/d)	44,575	51,280	44,965	48,205	51,020
OPEC production (000 b/d)	27,535	31,470	18,435	19,115	23,215

*Organization for Economic Cooperation and Development; and lesser developed countries

OPEC PRODUCTION/RESERVES RATIO

Country	Reserves Jan. 1, 1990 (Million bbl)	Production Av. 1989 (000 b/d)	Production First half 1989 (000 b/d)	Production/ Reserves (Years)
Saudi Arabia	254,959	4,995	5,499	140–127
Iraq	100,000	2,897	3,100	95–88
United Arab Emirates	98,105	1,866	2,068	144–130
Kuwait	94,525	1,593	1,809	163–143
Iran	92,860	2,947	3,050	86–83
Venezuela	58,504	1,725	2,024	93–79
Libya	22,800	1,130	1,316	55–47
Nigeria	16,000	1,672	1,766	26–25
Algeria	9,200	714	791	35–32
Indonesia	8,200	1,235	1,259	18–18
(Neutral Zone)*	5,200	397	359	36-40
Qatar	4,500	387	363	32–34
Ecuador	1,514	279	281	15–15
Gabon	733	211	259	10–8
Total OPEC	**767,100**	**22,048**	**23,944**	**95–88**
United States	**26,501**	**7,613**	**7,325**	**9.5–9.9**
All Non-OPEC Countries	**151,013**	**22,299**	**22,607**	**18.6–18.3**
Total Non-CPE's	**918,113**	**44,347**	**46,551**	**56.7–54.0**
Total CPE's	**84,100**	**15,280**	**14,863**	**15.1–15.5**
Total World	**1,002,213**	**59,627**	**61,414**	**46.0–44.7**

*Production shared by Kuwait and Saudi Arabia
Source: Oil & Gas Journal

OPEC REFINING CAPACITY

Country	1980	(Dec 31) 1982	1988	Change 1988-1982	% change 1988/1982
	(1,000 b/cd)				
Algeria	471.2	471.2	471.2	—	—
Ecuador	94.5	94.5	133.0	38.5	40.7
Gabon	44.0	44.0	21.0	−23.0	−52.3
Indonesia	473.4	473.4	738.7	265.3	56.0
Iran	1,320.0	670.0	615.0	−55.0	−8.2
Iraq	305.5	215.5	365.5	150.0	69.6
Kuwait	594.0	594.0	670.0	76.0	12.8
Libya	117.0	117.0	342.0	225.0	192.3
Nigeria	234.0	234.0	265.5	31.5	13.5
Qatar	10.5	13.0	63.0	50.0	384.6
Saudi Arabia	878.0	765.0	1,490.0	725.0	94.8
United Arab Emirates	13.5	121.5	162.0	40.5	33.3
Venezuela	1,444.9	1,323.1	1,201.1	−122.0	−9.2
Total OPEC	**6,000.5**	**5,136.2**	**6,538.0**	**1,401.8**	**27.3**

Source: OPEC Statistical Bulletin

demand it would be possible to slow and possibly stop the decline in prices.

World export prices had peaked in 1981 at about $35.50/bbl. OPEC prices were $34.80/bbl and non-OPEC prices $38.50/bbl. When demand started to slide, non-OPEC export producers undercut OPEC prices to retain market share. With this intense competition in the market world, export posted prices fell to $33/bbl in January 1983. The OPEC price was $33.50/bbl and the non-OPEC price $31.70/bbl.

OPEC adopted their first set of quotas in March 1983, at 17.5 million b/d. Even with the OPEC production quotas, prices continued to slide. Therefore, in a renewed attempt to balance the market, OPEC lowered the quota to 16 million b/d in November 1984. Adoption of this lower production level did manage to support prices throughout 1984 and 1985.

But a disproportionate share of the cut in OPEC production was being borne by Saudi Arabia. They had adopted or accepted the role of swing producer within OPEC. They cut their production to help OPEC stay within the quota and prevent a fall in crude prices. By 1985, Saudi production had fallen to an average of 3.175 million b/d. This was down 6.633 million b/d, 67.6% from 9.808 million b/d in 1981. Total OPEC production had fallen only 6.502 million b/d, 28.8%. With the Saudis willing to play the swing producer role, many of the other OPEC members could sustain their production and not have to sacrifice output to support prices.

In the summer of 1985, Saudi production fell below 2 million b/d and they realized that supporting the OPEC quota unilaterally could be disastrous. At this point they abandoned the swing producer role and adopted a "net-back pricing" scheme to recapture market share. This introduced price competition among OPEC members. Other OPEC countries followed. In December of that year OPEC adopted a market share goal and abandoned the goal of supporting a price level. This resulted in an excessive volume of crude oil on the market. Thus, when winter petroleum demand subsided in early 1986, prices collapsed.

The average export price of OPEC crude fell below $10/bbl by August 1986. In response to the price collapse, OPEC adopted an emergency quota of 16.7 million b/d in September. This helped boost prices to over $13/bbl in September 1986 and up to over $17/bbl by January 1987.

Member countries seemed to learn something from the 1986 experience with the market.

OPEC producers stayed close to their quota in 1987, and prices remained above $17/bbl for the year. But some difficulties developed. Iraq had managed to overcome the impact of the war on their production and exports, and their crude production was beginning to move up rapidly. They refused to be part of the adopted OPEC quota system. In addition, the UAE had internal problems satisfying the output demands of both Abu Dhabi and Dubai, and they also began producing above quota.

With this excess crude available in the market, after winter demand peaked in early 1988, prices started to slide again. Saudi Arabia adamantly refused to re-adopt the role of swing producer and instead boosted their own production. By October 1988, the prices of some OPEC export crudes had again fallen below $10/bbl. Increased winter demand helped boost prices a bit toward the end of the year. However, OPEC met and adopted a new quota for the first part of 1989 in an attempt to boost prices more.

They set a quota at 18.5 million b/d. Some production discipline and increased demand for oil helped boost prices in 1989. In order to satisfy some member countries and in response to increased demand, OPEC raised the quota to 19.5 million b/d starting July 1989 and to 20.5 million b/d starting October 1989. Prices remained relatively firm and OPEC boosted the quota even further to 22.086 million b/d starting January 1990.

During the first half of 1990, OPEC overproduction led to some price weakness. A substantial portion of the additional production was from the UAE which disagreed with the dictated quota. To bring the quota more in line with reality and to satisfy the objections of the UAE, OPEC adopted an adjusted quota of 22.491 million b/d to go into affect August 1, 1990. Even though prices were weak, OPEC felt that production discipline at the new quota level and increased winter demand would help boost prices.

Iraq invaded Kuwait before the new quota could take effect. The invasion created a much different market.

Before the conflict it appeared obvious that the key to sustaining an acceptable price level was OPEC adherence to a quota that comes close to balancing supply and demand. And the problem for OPEC was finding a quota and allocation of production method that would satisfy all of its members. If the dispute is resolved and OPEC stays intact, this may again be the key to adequate and stable prices.

OPEC PRODUCTION QUOTAS

(1,000 b/d)

Country	1984* quota	1984 production	1988 quota	1988 production	1989* quota	1989 production
Algeria	663	508	667	641	771	714
Ecuador	183	258	221	305	254	279
Gabon	137	150	159	175	184	211
Indonesia	1,189	1,423	1,190	1,138	1,374	1,235
Iran	2,300	2,174	2,369	2,240	2,926	2,947
Iraq	1,200	1,210	1,540	2,688	2,926	2,897
Kuwait	900	945	996	1,335	1,149	1,593
Libya	990	1,091	996	1,025	1,149	1,130
Neutral Zone	†	439	†	313	†	397
Nigeria	1,300	1,414	1,301	1,390	1,501	1,672
Qatar	280	396	299	346	346	387
Saudi Arabia	4,353	4,464	4,343	4,946	5,014	4,995
United Arab Emirates	950	1,159	948	1,474	1,094	1,866
Venezuela	1,555	1,711	1,571	1,649	1,812	1,725
Total	**16,000**	**17,442**	**16,600**	**19,665**	**20,500**	**22,048**

*Production quotas did not apply for full year. †Quota does not apply to Neutral Zone. Production shared by Kuwait and Saudi Arabia.

Source: OPEC and Author's estimates

VALUE—OPEC PETROLEUM EXPORTS

Year	Crude exports	Product exports (1,000 b/d)	Total exports	Value of exports ($ million)	Average value ($ bbl)
1980	22,866.7	2,011.1	24,877.8	284,503	31.33
1981	18,549.9	1,980.6	20,530.5	263,243	35.13
1982	14,269.8	2,226.4	16,496.2	202,778	33.68
1983	12,473.4	2,022.8	14,496.2	157,134	29.70
1984	12,023.4	2,281.8	14,305.2	143,663	27.51
1985	10,805.1	2,410.2	13,215.3	127,181	26.37
1986	12,830.2	2,673.7	15,503.9	77,314	13.66
1987	11,965.7	2,925.3	14,891.0	93,042	17.12
1988	13,576.9	3,186.2	16,763.1	96,364	14.12
Average	14,373.5	2,413.1	16,786.6	159,469	26.03

Source: OPEC Statistical Bulletin

OPEC RESERVES AND FUTURE PRODUCTION. Looking at OPEC member country reserves and their reserves to production ratios, it is apparent that OPEC is split into two or three distinct groups.

Ranked by reserves, the top six OPEC

countries have 699 billion barrels of proven reserves. These six countries have 91.1% of OPEC reserves, 83.6% of non-communist reserves and 69.7% of total world reserves. Looking at their reserves to production ratios these individual countries all have close to or over 100 years of reserves. This is at the 1988–89 rate of production.

The remaining eight OPEC countries have reserves equivalent to 10–55 years of current production. Libya is caught in the middle with about 55 years. Nigeria, Algeria and Qatar have 25–35 years, and the remainder have 20 years or less.

It is obvious that these groups have different short- and long-run objectives. The "big six" producing countries want a higher price for their crude oil, but they don't want to stifle the long run growth in world demand for petroleum. Their crude oil would have little value if conservation, fuel switching and investment in alternative energy and energy efficiency left that oil in the ground. These countries are trying to find a production level that will provide sufficient current revenues but still stimulate demand.

The other group can not expect to sustain production at present levels for an extended period. They therefore are more interested in immediate revenue.

With the production capacity and reserves, it would appear that the "OPEC Big Six" will control OPEC policy. Under present economic conditions it would appear that the price they are looking for is $18–25/bbl. Getting to that price level and sustaining it is the dilemma facing OPEC.

It is obvious from the reserves data that if oil is to be a major energy source for economic growth in the future, then OPEC will be the major supplier. The OPEC group of countries has 76.5% of world oil reserves. However, to take advantage of this key position in the worldwide economic structure, they have to find some way to stabilize the political conditions in the Middle East. If they do, they will be in an ideal position in the oil market for years to come.

OTHER FORECASTS

Developing an outlook to be used for planning, operating and investment decisions can be a complex and difficult task. It is often quite worthwhile to review a collection of other views, opinions and forecasts. This can be a rewarding exercise. It reveals other ways that current activities and events can be interpreted and projected.

Several groups have made long-range forecasts of the U.S. and worldwide energy and oil industry.

Unfortunately these forecasts were developed prior to the recent upheaval in the Middle East. However, they are long-range forecasts and the trends they project indicate the underlying economic forces working in the industry. They present expectations for the industry absent of political upheavals like the current situation in the Middle East. Reviewing this variety of outlooks will provide some additional expert opinions about the shape of the future of the oil industry.

Following is a brief summary of the highlights from several of these forecasts.

ENERGY INFORMATION ADMINISTRATION (EIA)

The U.S. Energy Information Administration (EIA), a part of the U. S. Department of Energy, came out with two publications containing their long-range U.S. oil and gas forecast: "Annual Outlook for Oil and Gas, 1990" and "Annual Energy Outlook 1990, with Projections to 2010." Both of these studies made projections out to the year 2010 and the projections in the two reports contained some differences. The "Annual Energy Outlook" was published in January 1990 while the "Annual Outlook for Oil and Gas" was published in May 1990. The highlights of the latter report are reviewed here.

The EIA also published an outlook for the worldwide oil and gas industry, "International Energy Outlook 1990." That report was published in March 1990 and the highlights are also presented in this chapter.

U.S. OUTLOOK

Three separate scenarios were presented based upon three separate price projections: low world oil prices, base case or middle price case, and high world oil prices. In the report the EIA points out that, "Major fluctuations have occurred in the historical prices of crude oil and natural gas and the possibility of future price instability creates considerable uncertainty concerning the future direction of prices and economic incentives for the domestic production industry." They present three possible price cases and the results of each. They also present two other cases involving high economic growth rate and a low economic growth rate.

Under all three cases, prices are expected to move up over the long-range outlook. However, "None of the alternative world oil price paths reaches the level seen in the 1980 to 1981 period."

With respect to the effect of world oil prices the EIA report states, "The assumed world crude oil prices are a dominant influence on the base case forecast. The world crude oil price directly affects the domestic production and consumption of petroleum. In the absence of price controls or import quotas, the domestic crude oil price adjusts to the world oil price."

In the base case, the world price of oil (in constant 1989 dollars) moves up from $18.07/bbl in 1989 to $20.40/bbl in 1995, $27.80/bbl in 2000 and 32.90/bbl in 2010. Over the first period, 1989 to 1995, the price moves up a bit slower, 12.9%. From 1995 to 2000 the price increases 36.3%. Over the next five years, 2000 to 2005, the price increase 18.3% and over the period 2005 to 2010 the price moves up 12.2%.

In the low price scenario, world crude oil prices fall to $14.40/bbl in 1995 and then move up to $19.80/bbl in 2000, $23.90/bbl in 2005, and $25.90/bbl in 2010. In this case, prices fall 20.8% by 1995. Then prices move up 38.5% from 1995 to 2000, up 20.7% from 2000 to 2005, and up 8.4% from 2005 to 2010.

With the high price scenario, the rate of increase is much greater. Under this case, the world crude oil price jumps to $25.90/bbl in 1995, $33.90/bbl in 2000, $41.90/bbl in 2005 and $47.40/bbl in 2010. Prices are up 43.3% by 1995.

HIGHLIGHTS
ENERGY INFORMATION ADMINISTRATION
ANNUAL OUTLOOK FOR OIL AND GAS 1990

Petroleum Supply and Disposition Balance

Supply and Disposition	1988	1989	Base Case 1995	2000	2005	2010
World Oil Price (1989 $/bbl)	**15.27**	**18.07**	**20.40**	**27.80**	**32.90**	**36.90**
Supply (million bbl/d)						
Production						
Crude Oil	8.14	7.63	6.34	5.88	5.39	4.85
Natural Gas Plant Liquids	1.62	1.55	1.61	1.75	1.73	1.69
Other Domestic	0.05	0.06	0.15	0.24	0.34	0.55
Processing Gain	0.66	0.63	0.63	0.64	0.67	0.70
Total Production	**10.47**	**9.87**	**8.74**	**8.52**	**8.13**	**7.79**
Imports (including SPR)						
Crude Oil	5.11	5.81	7.67	8.31	9.32	10.41
Refined Products	2.30	2.17	2.42	2.51	2.59	2.68
Total Imports	7.40	7.98	10.09	10.83	11.91	13.09
Exports	0.82	0.86	0.79	0.80	0.82	0.85
Net Imports (including SPR)	6.59	7.12	9.30	10.03	11.09	12.24
Primary Stock Changes						
Net Withdrawals	0.08	0.10	−0.02	−0.01	−0.03	−0.02
SPR Fill Rate Additions(-)	−0.05	−0.06	−0.05	0.00	0.00	0.00
Total Supply	**17.09**	**17.03**	**17.96**	**18.53**	**19.19**	**20.02**
Products Supplied (million bbl/d)						
Motor Gasoline	7.34	7.33	7.52	7.69	8.00	8.38
Jet Fuel	1.45	1.49	1.63	1.73	1.8[illegible]	1.98
Distillate Fuel	3.12	3.15	3.32	3.39	3.51	3.68
Residual Fuel	1.38	1.35	1.46	1.49	1.41	1.34
Other Petroleum Products	4.00	3.92	4.25	4.45	4.65	4.87
Total Products Supplied	**17.28**	**17.24**	**18.18**	**18.75**	**19.42**	**20.25**
Product Consumption						
Residential and Commercial	1.39	1.33	1.17	1.03	0.94	0.89
Industrial	4.31	4.16	4.83	5.07	5.32	5.62
Transportation	10.79	10.95	11.25	11.70	12.31	13.02
Electric Utilities	0.79	0.81	0.93	0.95	0.84	0.72
Total Product Consumption	**17.28**	**17.24**	**18.18**	**18.75**	**19.42**	**20.25**
End-Use Prices (1989 dollars per gallon)						
Motor Gasoline	0.97	1.02	1.02	1.21	1.32	1.41
Jet Fuel	0.54	0.59	0.71	0.89	1.04	1.17
Diesel	0.96	1.00	1.10	1.26	1.40	1.51
No. 2 Heating Oil	0.85	0.90	0.88	1.05	1.19	1.30
Residual Fuel-Utilities	0.38	0.41	0.51	0.69	0.82	0.94
Residual Fuel-Industrial	0.36	0.40	0.53	0.72	0.85	0.96

They move up 30.9% between 1995 and 2000. The prices continue to move up, increasing 23.6% from 2000 to 2005, and up 13.1% from 2005 to 2010.

According to the EIA Annual Outlook for Oil and Gas report, the economic growth rate in the base case is about 2.4%/year. Under the low growth assumption, the economic growth rate is 2%/year. And under the high growth assumption, the rate is 2.8%/year. These growth rates are lower than the pace of U.S. economic growth since 1970.

In the Annual Energy Outlook, the EIA projects a continuing improvement in energy efficiency over the forecast period. The trend in the ratio of energy use to economic output has been declining since 1970. U.S. energy consumption is expected to increase at about half the rate of economic growth over the forecast period. Energy efficiency improvements and shifts in economic activity from energy-intensive sectors to less energy intensive sectors will slow energy consumption.

Also in the Annual Energy Outlook, the EIA comments on energy and the environment.

HIGHLIGHTS
ASHLAND LONG TERM WORLD ENERGY DEMAND

Non Communist World crude oil supply/demand balance outlook
(Million b/d)

	Actual			Base-line scenario projections		
	1979	1985	1988	1990	1995	2000
Demand:						
U.S.	18.8	15.9	17.1	17.4	17.8	18.1
Other	33.1	30.3	33.0	34.7	36.6	38.4
Total	**51.9**	**46.2**	**50.1**	**52.1**	**54.4**	**56.5**
Supply:						
Inventory adjustment:						
Draw (+), build (−)	−1.5	+0.6	−0.02	—	—	—
Non-OPEC crude oil & NGL	19.6	25.7	26.2	25-26	24-26	22-24
CPE net export	1.2	1.8	2.2	2.0-2.3	1.8-2.2	1.5-2.0
OPEC NGL & processing gain	1.7	2.1	2.6	2.6	2.8	3.0
	21.0	30.2	30.8	29.6-30.9	28.6-31.0	26.5-29.0
OPEC Production	30.9	16.0	19.3	21.2-22.5	23.4-25.8	27.5-30.0
Total	**51.9**	**46.2**	**50.1**	**52.1**	**54.4**	**56.5**
OPEC market share	60%	35%	39%	41%-43%	43%-47%	49%-53%
OPEC capacity	34	30	26	30	32	35
OPEC operating rate	90%	53%	75%	71%-75%	73%-81%	79%-86%

The EIA made these comments, "The U.S. economy is forecast to become increasingly dependent on fossil fuels, especially coal. Even as total consumption of energy grows by almost 30% in the next 20 years, the share of coal grows from 23% in 1989 to 26–27% in 2010. Coal demand is driven predominantly by the demand for electricity. The share accounted for by petroleum products declines by a comparable amount, but this masks a total increase of almost 20% in oil use over the forecast. Thus it may be expected that today's concerns with acid rain, local automobile related pollution and global warming will not go away soon."

These assumptions are part of the basis for the EIA outlook for U.S. oil and natural gas from to the year 2010. Following is a brief summary of the EIA projections for oil and natural gas consumption and production over the forecast period.

Under the base case price scenario the EIA projects U.S. total demand (total products supplied) for petroleum products to move up to 18.75 million b/d in 2000, and to 20.25 million b/d in 2010. This is an increase of only 8.8% from 1989 to 1995. Over the next 10 years, 2000 to 2010, total demand is projected to move up another 8%.

Demand for motor gasoline is expected to move up 11.4% over the entire forecast period, 1989 to 2010. Motor gasoline demand will increase to 7.52 million b/d in 1995, 7.69 million b/d in 2000 and 8.38 million b/d in 2010. Commenting on motor gasoline demand, the EIA report stated. "Slow demand growth is attributed to increased vehicle fuel efficiency, retirement of older less fuel efficient vehicles and higher motor gasoline prices. Together these factors are expected to nearly offset growth resulting from projected increase in travel as measured by vehicle miles

traveled. Motor gasoline prices are projected to grow at an annual rate of 1.6% from an average of $1.02/gal in 1989 to an average $1.41/gal in 2010."

Distillate demand is forecast to increase 16.8% over the forecast period 1989 to 2010, to 3.68 million b/d in 2010. The EIA report states, "Growth in distillate fuel oil use is expected to be constrained in part by increasing fuel oil prices throughout the forecast period. Transportation distillate demand is projected to grow at an average rate of 1.7%/year as a result of increased truck, rail and auto traffic throughout the forecast period. By 2010 transportation demand is expected to reach 2.4 million b/d accounting for 64% of total distillate demand."

Jet fuel demand will move up 32.9% over the forecast period, 1989 to 2010, moving up to 1.98 million b/d. According to the EIA report, "Increased demand for jet fuel stems from a rise in demand for kerosine jet fuel for commercial aviation." After 1995 the growth rate in demand for jet fuel will slow. "The slowdown in growth results largely from an easing in passenger and freight travel, continued improvements in aircraft efficiency, and higher fuel prices."

Demand for residual fuel oil is projected to increase 10.4% by the year 2000, moving up to 1.49 million b/d. Between 2000 and 2010 demand is expected to fall 10.1%, to 1.34 million b/d at the end of the forecast period. According to the EIA, "Transportation demand and electric utility demand are projected to be the main sources for growing residual fuel use; however end-use fuel requirements in these sectors are expected to fluctuate throughout the forecast period. Transportation demand is expected to grow at an annual rate of 1.5% as a result of increased international trade requiring growing volumes of residual bunker fuel for shipping. Much of the decline in demand by industrial and commercial users stems from displacement by natural gas, coal and electricity, as well as ongoing conservation efforts."

On the supply side, the EIA projects declining domestic crude production throughout the forecast period. Total U.S. crude oil production is projected to fall 36.4%, to 4.85 million b/d in 2010. Alaskan production is also forecast to fall steadily during the period, dropping to only 460,000 b/d in 2010. Lower-48 production is forecast to fall to 4.39 million b/d in 2010.

With increasing demand and declining domestic production, imports of crude oil and petroleum products are projected to increase 64%, to 13.09 million b/d in 2010. Net imports (total imports minus exports) are forecast to increase 71.9%, to 12.24 million b/d in 2010. Net imports as a percentage of domestic demand are projected to move up from 41.3% in 1989 to 60.4% in 2010.

The EIA report also projects growth in the natural gas industry over the same period. With respect to the natural gas projections, the EIA report states, "Projections of the future course of the natural gas market depend on the likely effects of decreasing the regulation of the natural gas industry. Until recently the industry was heavily regulated by State and Federal authorities and had developed institutions that were adapted to a controlled environment. Over the past decade legislative and regulatory policy and market forces have combined to increase the competitiveness of natural gas markets in the United States."

"Perhaps the single most important development of the 1980s in the natural gas industry has been the progressive unbundling of the transportation and sales function. The development of spot and transportation markets has made possible a much more varied marketing chain for gas than that which existed before the 1980s."

With regard to natural gas prices over the forecast period, the EIA states, "The costs of producing and transporting gas over the long term are expected to remain low enough that end-use customers will have little incentive to switch to residual or distillate fuel oil in spite of the increasing share of gas produced from more expensive sources."

The average wellhead price for natural

gas in 1989 dollars is projected to increase 88.9%, to $3.23/mcf in 2000. It will continue to move up to $5.69/mcf in 2010.

As a result of competitive prices, demand for natural gas will increase steadily through 2005. In that year, consumption will be up 20.5% from 1989 at 22.84 tcf. Demand will then slip to 22.4 tcf in 2010, down 2%.

Electric utility consumption is projected to increase through 2005, moving up 127.1%, to 6.29 tcf. Growth in this sector is the major reason for the steady growth in total gas consumption. After 2005, electric utility demand will fall, dropping 5.9%, to 5.92 tcf in 2010. With regard to electric utility demand, the EIA report states, "The continued increase in total consumption of natural gas comes largely from increases in the electric utility sector which shows a major shift toward increased natural gas use throughout most of the forecast period. Electric utility consumption is projected to represent an increasing share of the gas market, from 14.2% of total gas consumption in 1989 to 20% by 1995 and to a range of 26–28% from 2000 to 2010.

"In the electric utility sector gas prices are projected to remain below residual and distillate fuel oil prices throughout the forecast period; however the gap between the prices narrows as gas wellhead prices increase faster than oil prices.

"Following the year 2000 coal begins to gain market share from gas in the electric utility sector as new advanced technologies for electricity generation become available."

Residential and commercial demand for natural gas is projected to fall gradually over the forecast period. Consumption in the residential sector will be down 5.2% by 2010, at 4.59 tcf. In the commercial sector demand will be down 7.7%, at 2.52 tcf in 2010. Industrial consumption is projected to increase through 2000 and then fall slowly to 2010. Consumption at the end of the forecast period will still be up 4.2%, at 7.13 tcf in 2010.

U.S. domestic production of dry gas is projected to move up through 2000, increasing 21.1% to 20.62 tcf. From 2000 through 2010 production will slip 3.6%, to 19.88 tcf.

Imports of natural gas, both pipeline and LNG, will increase steadily through most of the forecast period. Total imports will move up 125%, from 1.31 tcf in 1989 to 2.95 tcf in 2005. Imports will remain at this level through 2010.

WORLDWIDE OUTLOOK

The EIA report "International Energy Outlook" reviews the worldwide international oil market and provides projections through the year 2010. In the discussion of world crude oil prices they commented on the recent difficulties OPEC has had managing its crude production. And crude prices over the early 1990s is dependent upon their management of the excess capacity via production controls.

The EIA report goes on to say. "Beyond the mid-1990's oil prices are expected to rise. Non-OPEC production is expected to peak and level off worldwide, while U.S. production will continue to decline.

"The degree to which oil prices will rise depends largely on OPEC behavior. Future OPEC production decisions will be determined by a variety of factors. Market forces determine the overall bounds within which OPEC can influence world oil markets, but within these bounds, market share and revenue goals, as well as political and security considerations, will exert great influence on OPEC production and capacity decisions. The most likely course is that pressure to earn more revenues, along with the expected increase in demand for OPEC oil, will continue to encourage OPEC member nations to expand their production capacities in the future. The market strategies eventually chosen by OPEC will determine the rate of capacity expansion and whether this expansion will keep up with demand growth."

According to the EIA, "Economic growth

and therefore energy consumption may grow more rapidly in many developing countries because they are starting from a relatively low base. In the OECD countries economic growth is projected to be slightly higher in the North American countries—Canada and the United States—and in the Pacific countries—Japan, Australia, and New Zealand—than in the individual European countries. Under mid-case assumptions economic growth in the North American and Pacific countries is projected to grow at or slightly above 2.5%/year between now and the year 2000 and slightly below 2.5%/year between 2000 and 2010. In European countries the economy is projected to grow at slightly below 2%/year from now through 2010; growth in the developing countries is projected at an average rate of about 3%/year over the next 20 years; growth in the Centrally Planned Economies is projected at about the same rate as the Market Economies taken together between 2000 and 2010."

Following is a review of some of the EIA international worldwide projections.

Total consumption of petroleum products by the Market Economies is projected to increase throughout the forecast period 1989–2010. Total demand is projected to be up 9.8% from 1989, at 57.02 million b/d in 2000, and up 13.7%, at 59.03 million b/d in 2010. U.S. demand is expected to rise throughout the period, increasing 17.8%, to 20.32 million b/d in 2010. Japanese demand will peak in 1995 at 5.77 million b/d and then fall to 5.02 million b/d in 2010. This is about the same level as 1989 Japanese demand of 5.01 million b/d. Petroleum product demand in the European OECD countries will follow a similar pattern, rising to 12.92 million b/d in 1995 and then declining to 11.82 million b/d in 2010. Demand in 2010 will be down 5.7% from the 12.54 million b/d in 1989. Demand in the developing countries will move up throughout the forecast period, increasing 29.7%, to 18.75 million b/d in 2010.

On the supply side of the equation, crude oil production in the Market Economies is also projected to increase throughout the forecast period to keep pace with demand. Imports from the Centrally Planned Economies will decline throughout the forecast period, so production will have to move up slightly faster than demand.

Crude oil production will move up 17.3%, to 58.79 million b/d in 2010. This will be an increase of 8.68 million b/d. U.S. production will decline throughout this period, falling 2.14 million b/d, to 7.83 million b/d in 2010. Canadian production will be up about 5.5% in 2010. European production will peak in 2000 and then fall back to 4.44 million b/d, down slightly from the 4.47 million b/d in 1989. Other non-OPEC production will peak in 1995 and then slowly decline to 10.37 million b/d in 2010, up 130,000 b/d from 1989. Increased OPEC production will make up for most of the increase in worldwide demand for oil. OPEC production will increase 45.3%, to 34.05 million b/d in 2010, an increase of 10.61 million b/d.

Imports from the Centrally Planned Economies are expected to fall from 2.3 million b/d in 1989 to 1.53 million b/d in 2000. After 2000 the imports from the CPEs will decline rapidly and by 2010 EIA expects these counties to be net importers of about 70,000 b/d.

Looking at the worldwide energy mix over the forecast period, the EIA concluded that, "Oil will continue to be the world's single most important source of energy over the next 20 years but growth in oil consumption is expected to proceed at a much lower rate than that of other energy sources.

"Natural gas is expected to be the fastest growing fossil fuel through the year 2010. Natural gas supplies are abundant relative to oil supplies and relative to its lower absolute level of consumption. In 2010 for example natural gas would still supply only about one-half as much of the energy needs in the Market Economies compared with oil's contribution."

In the Centrally Planned Economies the EIA expects both oil consumption and oil produc-

tion to decline over the forecast period. Consumption is expected to decline as these economies embrace a great deal more energy conservation. Total consumption is expected to fall 17.7% by 2010, to 10.97 million b/d. This is a decline of 2.37 million b/d. A large portion of this reduction will be in the U.S.S.R. where consumption is expected to decline 1.78 million b/d, to 7.06 million b/d in 2010. Most of the remainder of the reduction is expected to be in the other Eastern European countries where consumption will fall 20%, to 1.89 million b/d. Consumption in China is expected to decline only 5.6% by 2010.

Total production for this group will fall throughout the forecast period but much more rapidly after 2000. In 1989, total production for the CPEs was 15.43 million b/d. This is projected to dip to 13.6 million b/d in 2000 and to 10.9 million b/d in 2010. Production in the U.S.S.R. is projected to fall from 12.23 million b/d to 8.16 million b/d in 2010. Chinese production will rise until 1995 and then start falling. China's production averaged 2.73 million b/d in 1989 and is expected to move up to 2.82 million b/d in 1995. It will then fall to 2.5 million b/d in 2010.

By the year 2010, the CPEs will no longer be self sufficient in petroleum. In that year consumption will exceed production by 70,000 b/d. The U.S.S.R. and China will still be producing enough oil to meet their consumption needs, but not enough to cover the needs of the other CPEs.

ASHLAND OIL, INC.

Ashland Oil published a report, "Long Term World Energy Outlook," in January 1990. This report was prepared by their Chief Economist and Director of Market Research, Dr. Cyrus Hussein Tahmassebi. In this report Ashland presented their worldwide projections of oil price, energy demand, oil supply and oil demand through the year 2000.

The report listed, "A number of major developments with significant ramifications for the world oil markets," that took place in 1988 and early 1989. This did not include the Iraq invasion of Kuwait that took place in August 1990. This list included the following events:

- OPEC's de facto abandonment of the official selling price regime and adoption of a market-related pricing policy.
- Acceleration in OPEC's move into downstream integration.
- Ending of the Iran-Iraq War, OPEC's agreement on production parity for these two countries and Iraq's return to the OPEC quota system.
- Further declines in the value of the U.S. dollar and severe erosion in oil prices in local currencies in Europe and Japan
- Accelerating growth in demand for oil products, particularly gasoline, in major consuming countries.
- Rising U.S. oil imports, resulting from strong demand growth and further declines in domestic oil production.
- Significant upward revisions in the demand data published by the International Energy Agency.
- Downward revision in production capacities in some of the major OPEC countries.
- Significant upward revision in oil and gas reserve estimates in most of the major producing countries within OPEC.
- Formal OPEC/non-OPEC dialogue aimed at initiating cooperation efforts to stabilize the oil markets.
- Growing concern in major consuming countries about such environmental issues as the greenhouse effect, depletion of ozone, and acid rain.
- Worsening financial conditions in OPEC countries manifested by widening budget deficits and current account imbalances, coupled with radical public reactions to austerity programs initiated to address these problems.
- New administration in the United States.
- Unveiling of a major plan by the administration

HIGHLIGHTS
ASHLAND LONG TEAM WORLD ENERGY OUTLOOK

U.S. oil supply/demand outlook
(Million b/d)

	Actual				Most-likely scenarios projections		
	1978	1983	1986	1988	1990	1995	2000
Consumption	18.9	15.2	16.3	17.1	17.4	17.8	18.1
Supply:							
Domestic crude oil	8.7	8.7	8.7	8.2	7.7	7.2	6.7
Domestic NGL	1.6	1.6	1.6	1.6	1.6	1.7	1.7
Net imports	7.5	4.1	5.4	6.3	7.0	7.9	8.7
Balancing factor*	1.1	0.8	0.6	1.0	1.1	1.0	1.0
Total	**18.9**	**15.2**	**16.3**	**17.1**	**17.4**	**17.8**	**18.1**
Net import as a percent of consumption	40%	27%	33%	37%	40%	44%	48%

*Includes about 0.6MM b/d of refinery processing gain, stock change and miscellaneous items.

to promote alternative fuels to combat pollution in major U.S. cities.

- Major accidents involving North Sea production and tanker traffic in Alaska and elsewhere.
- Sweeping political, social and economic transformation in the Soviet Union and the country's bold moves in arms reduction negotiations.
- De facto recognition of the State of Israel by the Palestinian Liberation Organization and improved prospects for peace in the Middle East.

Ashland would probably add some events to this list if the report was published later in 1990. The dispute in the Middle East between Iraq and Kuwait would probably lead the list.

Three price scenarios were presented in this report. The reference price used was Arab Light crude in the Persian Gulf. The base line scenario projected the current dollar price for crude oil moving up from $13.32/bbl in 1988, to $17.00/bbl in 1990, $25.00/bbl in 1995 and $35.00/bbl in 2000. The average annual rate of increase was 8.0% between 1990 and 1995, and 7.0% between 1995 and 2000.

The real price in 1988 dollars was forecast to move up at an annual rate of 2.8% per year from 1990 to 1995, and drop to 1.5% per year from 1995 to 2000. The inflation index projected is 5.1% from 1990 to 1995 and 5.4% from 1995 to 2000.

Ashland projected total free world demand for energy to move up 10.4% from 1990 to 1995. It then expects energy demand to increase 9.3% from 1995 to 2000. The average annual growth rate from 1990 to 2000 is projected at 1.9%.

Coal demand is projected to increase 25.7% from 1990 to 2000. Coal's market share would move up from 21.1% in 1990 to 21.9% in 2000. Natural gas demand is projected to increase 38.8% from 1990 to 2000. The market share for natural gas will increase from 18.6% in 1990 to 21.4% in 2000. Oil demand is expected to increase only 8.4% from 1990 to 2000. And oil will lose market share, falling from 46.3% in 1990 to 41.6% in 2000. Nuclear power in the free world will move up 30.7% over the ten-year period. The market share will move up from 6.7% in 1990 to 7.2% in 2000. Energy from hydro and other sources will increase 28.9% by the year 2000 and reach 7.9% of the energy market.

The base case projects world demand for petroleum products at 56.5 million b/d in 2000, up from 52.1 million b/d in 1990. This is a growth of 8.4% over the ten-year period.

On the supply side under this scenario, production of crude oil by the OPEC countries would move up to a range of 23.4–25.8 million b/d

HIGHLIGHTS
ENERGY INFORMATION ADMINISTRATION
INTERNATIONAL ENERGY OUTLOOK 1990

World Oil Consumption and Production Base Case

	1988	1989	1990	1995	2000	2010
Market Economies						
Production: (million bbl/day)						
United States	10.47	9.97	9.71	8.97	8.71	7.83
Canada	2.04	1.99	1.96	2.03	2.10	2.10
OECD Europe	4.44	4.47	4.96	5.29	5.16	4.44
OPEC	22.01	23.44	23.68	26.58	28.47	34.05
Other countries	10.11	10.24	10.67	11.06	10.73	10.37
Total Production	**49.07**	**50.11**	**50.98**	**53.93**	**55.17**	**58.79**
Net CPE imports	2.43	2.30	2.20	1.92	1.53	−0.07
Net stock change	−0.38	−0.80	−0.45	−0.05	+0.02	+0.01
Total supply	**51.12**	**51.61**	**52.73**	**55.80**	**56.72**	**58.73**
Consumption: (million bbl/day)						
U.S. (50 states)	17.28	17.25	17.41	18.21	18.84	20.32
U.S. Territories	0.20	0.21	0.20	0.21	0.22	0.23
Canada	1.60	1.67	1.68	1.91	1.96	1.90
Japan	4.73	5.01	5.20	5.77	5.65	5.02
Australia & New Zealand	0.77	0.80	0.81	0.88	0.91	1.00
OECD Europe	12.36	12.54	12.70	12.92	12.43	11.82
Other market economies	13.80	14.46	15.02	16.21	17.01	18.75
Total	**50.74**	**51.94**	**53.02**	**56.11**	**57.02**	**59.03**
World Oil Price (1989 dollars/bbl)	15.18	17.70	16.80	[illegible]	29.00	36.90

in 1995 from 21.2–22.5 million b/d in 1990. OPEC production would move up to a level of 27.5–30 million b/d in 2000. Non-OPEC crude oil and NGL is projected to be in a range of 24–26 million b/d in 1995 and 22–24 million b/d in 2000. These levels are down slightly from 25–26 million b/d in 1990.

The OPEC share of the market would increase from 45.7–48.2% in 1990 to 48.1–52.6% in 1995 and 54–58.4% in 2000. The report estimated current OPEC production capacity at 27.1 million b/d. Discussing the OPEC excess capacity, the Ashland report made the following comments, "Excess production capacity, costly as it might be, can benefit the producing countries individually and collectively. It provides certain leverage for the individual country within OPEC as others may perceive that any non-compliance with the country's wishes could induce it to use its excess capacity to the detriment of the others. Furthermore, excess capacity could enhance OPEC's collective bargaining position vis-a-vis non-OPEC in the former's quest for higher market share.

"However, the most significant advantage of maintaining relatively large excess capacity is its impact on market expectations. Maintaining a certain level of spare capacity creates a perception of secure supply at competitive prices. Such a perception is paramount to OPEC's desire for steady demand growth and its quest for higher market share."

This last point above is particularly interesting with respect to the recent crisis in the Persian Gulf area. The instability caused by the Iraqi invasion may convince the consuming countries to invest heavily in the development of alternative fuels.

With respect to the expectations for the U.S., the Ashland report pointed out several major issues that have to be addressed:

- Provision of an adequate energy supply to sustain U.S. economic growth, improve international competitiveness, and elevate the standard of living. Owing to the vastness of the country and early abundance of cheap oil and coal, the U.S. economy is structured on inexpensive

energy. The U.S. economy today still is the most energy-intensive among industrialized countries.

- Oil is the most important source of energy for transportation, but indigenous production is rapidly declining. Furthermore, due to their age and early depletion, the remaining U.S. fields are high cost relative to the Middle East and certain other areas. The United States can still revive its domestic production by more liberal tax policies or by extending exploration to such virgin areas as the Alaskan Natural Wildlife Refuge or California offshore. But the government is reluctant to provide tax incentives due to its vast budget deficit. The virgin areas are kept off limits due to the public's desire to protect the environment in these areas.

  There is plenty of oil in the Middle East and elsewhere that can be imported. However, it is generally perceived that overdependency on imported oil can be unwise and imprudent for a superpower. Furthermore, as was the case in the 1970s and early 1980s, foreign supply disruption can be very costly.
- The United States is endowed with an ample supply of natural gas and coal. It also has access to nuclear power technology which now supplies some 20% of the country's utility fuels. However, indigenous natural gas may not be sufficient to fill the gap if oil imports are kept in check. Moreover, the potential for natural gas is not likely to be fully utilized if world oil prices remain depressed.

Residential, commercial and industrial sectors can substitute electricity for oil and gas at competitive prices. The country has plenty of coal to generate electricity to meet the growing demand. It can also augment coal based electricity with nuclear power. But the heightened public concern manifested in recent years about acid rain, global warming and safety of nuclear power plants is likely to limit contributions of electricity from coal and nuclear power.

Ashland's outlook for U.S. supply and demand of oil was based on their expectations for world oil prices mentioned earlier. They expect consumption of petroleum products in the United States to move up steadily over the forecast period. Oil consumption is projected to move up from 17.4 million b/d in 1990 to 17.8 million b/d in 1995, an increase of only 2.3%. Consumption will move up to 18.1 million b/d, an additional 1.7%, from 1995 to 2000.

Looking at the supply side, the Ashland report expects domestic production to decline steadily over the forecast period. U.S. domestic crude oil production will fall from 7.7 million b/d in 1990, to 7.2 million b/d in 1995, and 6.7 million b/d in 2000. Over the period 1990 to 2000, production will fall 13%.

To fill the gap between increasing demand and declining domestic production, imports will rise steadily throughout the forecast period. Net imports will move up from 7 million b/d in 1990, to 7.9 million b/d in 1995, and 8.7 million b/d in 2000. This would be a 24.3% increase in imports over the 1990–2000 period. Net imports as a percent of consumption will move up from 40% in 1990, to 44% in 1995, and 48% in 2000.

The Ashland report discusses this growing percentage of imports, and they point out a difference between dependency and vulnerability. According to the Ashland report, "These two often may not be the same. For example, a high dependency on imported oil in a surplus market environment might be much less risky than a relatively low dependency in a tight market.

"As a result of numerous structural changes that have taken place in the United States and in world oil markets, America is now probably less vulnerable to a supply disruption than it was 10 years ago. However, as demand and supply become balanced in the late 1990's some of the risk factors that were present 10 years ago are likely to re-emerge.

"Rather than depending on a pre-estab-

HIGHLIGHTS
ENERGY INFORMATION ADMINISTRATION
ANNUAL OUTLOOK FOR OIL AND GAS 1990

Natural Gas Supply, Consumption, and Prices

Supply, Consumption and Prices	1988	1989	Base Case 1995	2000	2005	2010
Supply (trillion cubic feet)						
Dry Production	16.99	17.03	18.95	20.62	20.37	19.88
Synthetic Production	0.10	0.16	0.12	0.13	0.19	0.25
Net Pipeline Imports	1.25	1.32	1.68	2.13	2.23	2.23
Net LNG Imports	-0.03	0.01	0.38	0.56	0.72	0.72
Net Storage Withdrawals	0.06	0.36	0.00	0.00	0.00	0.00
Total Supply	**18.37**	**18.86**	**21.14**	**23.43**	**23.50**	**23.07**
Consumption (trillion cubic feet)						
Residential	4.63	4.84	4.69	4.67	4.64	4.59
Commercial	2.67	2.73	2.65	2.59	2.55	2.52
Industrial	6.38	6.84	7.20	7.29	7.18	7.13
Lease & Plant Fuel	1.09	1.18	1.18	1.33	1.42	1.49
Pipeline Fuel	0.61	0.59	0.70	0.77	0.77	0.75
Electric Utilities	2.63	2.77	4.17	6.14	6.29	5.92
Total Consumption	**18.03**	**18.95**	**20.59**	**22.80**	**22.84**	**22.40**
Unaccounted for	0.34	-0.09	0.55	0.63	0.66	0.68
Price (1989 dollars per thousand cubic feet)						
Average Wellhead	1.76	1.71	2.22	3.23	4.36	5.69
Average Delivered						
Residential	5.70	5.63	6.18	7.18	8.30	9.63
Commercial	4.83	4.79	5.29	6.30	7.42	8.74
Industrial	3.08	2.92	3.43	4.46	5.57	6.85
Electric Utilities	2.44	2.43	2.91	3.87	4.91	5.99
Average to All Sectors	**4.01**	**3.90**	**4.27**	**5.13**	**6.21**	**7.46**

lished import ceiling, maybe what is needed is a 'vulnerability index'. This index can encompass numerous risk factors, rather than just one element, as is the case with a predetermined cutoff point. The index can be revised periodically as needed by future structural changes in the U.S. and/or by world oil market conditions."

The Ashland report also comments on natural gas prices and their relationship to oil prices. "Natural gas prices should logically follow oil prices closely. However, past experience has shown this may not be the case. Natural gas prices follow oil in the absence of surplus gas capacity or the so-called gas-to-gas competition. Even in a relatively balanced market, gas prices could suffer in a cyclical economic downturn or in a recession induced by a sudden jump in oil prices."

They also point out that, "In recent years, U.S. natural gas wellhead prices have averaged about 64% of parity with domestic crude oils. We believe this percentage will rise substantially as the gas bubble is eliminated.

"In fact, owing to its clean burning properties, natural gas is likely to command a certain premium over oil at the burner tip in the years ahead. Exactly when that might take place is difficult to predict due to uncertainty over environmental legislation."

As a most likely case, Ashland projects gas prices at 80–85% of parity by 1995 and 90–95% by the year 2000. That would put current dollar gas prices at $3.67–$3.90/million BTU in 1995. Prices would move up to $5.62–$5.94/million BTU in the year 2000.